



Department for
Energy Security
& Net Zero

Smart Energy Savings Competition (SENS): More Effective and Efficient Thermal comfort with Smart meter data (MEETS)

Trial Level Evaluation Report

June 2023

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Executive Summary

Rationale for and objectives of the SENS Competition

Smart meters are replacing traditional gas and electricity meters in homes and small businesses across Great Britain as part of an important upgrade to the national energy infrastructure, underpinning the cost-effective delivery of Government's Net Zero commitment. They are a critical tool in the transition to a low carbon energy system, for example helping consumers to use energy when renewable generation is available. Prior to the Competition, BEIS found that smart meters would result in average reductions of 3% for electricity customers, 2.2% for gas credit customers, and 0.5% for gas pre-payment customers¹.

Early evaluation and research showed that such savings can be realised through access to near real time feedback (via In-Home Displays, IHDs), energy efficiency advice at the point of installation, and accurate bills². The Smart Energy Savings Innovation (SENS) Competition was developed on the assumption that more sophisticated uses of energy consumption data can deliver additional savings to those already achieved by having a smart meter installed in the home.

The SENS Competition, led by the former Department for Business, Energy and Industrial Strategy (BEIS), committed up to £6.25 million to support the development, trialling and evaluation of innovative feedback products and services that use smart meter data to help domestic consumers reduce their energy consumption. SENS was launched February 2019, with trials concluding end of March 2022 (extended by one-year due to COVID-19 impacts).

The objectives of the Competition were to:

- Identify innovative products and services using smart meter data, which can deliver energy savings in homes in excess of those currently identified in the smart meter impact assessment, for either the Great Britain population or specific groups within it.
- Ensure that solutions are attractive and valued by consumers and are easily available (using existing technologies and delivery channels or cost-effective new hardware).
- Support the development of a domestic market for energy management products and services, securing investment from technology providers, energy suppliers, and third parties.

1

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/831716/smart-meter-roll-out-cost-benefit-analysis-2019.pdf

² <https://www.gov.uk/government/publications/smart-metering-early-learning-project-and-small-scale-behaviour-trials>

Overview of the SENS product

The SENS 'More Effective and Efficient Thermal comfort with smart meter data' (MEETS) innovation project was delivered by Lightbulb ES Limited, in partnership with Build Test Solutions Limited and the University College London (UCL) Energy Institute.

SENS MEETS was a three-part package delivered primarily through an online web-based application, and email notifications. The first part – 'Me and My Home' – presented trialists at the start of the trial with an online picture of their gas and electricity consumption, using smart meter data in combination with an existing data platform owned by Igloo Energy Supply Limited. Trialists were then offered a temperature logger which gathered data on patterns of heating within their home, resulting in a one-off household heating report that summarised the homes' heating performance (estimated using smart meter consumption and thermostat temperature data), benchmarked against comparator homes, and identified trialists who could benefit from the purchase of a smart thermostat. Finally, households received a package of coaching and tips on more effective heating control based on the home performance and external weather temperature data.

These three sequential parts were underpinned by a series of components integrated to support understanding of heating patterns and effective control of heating in the home, to promote gas consumption savings. Of the 932 trialists recruited to receive the SENS MEETS intervention, 891 completed their 'Me and My Home' profile (at least partially), 598 ordered and received a temperature logger, 313 returned their logged data, 304 received the heating report and 265 received coaching messages.

While the first component of this intervention proceeded largely as planned, the collection of heating pattern data and delivery of detailed coaching based on smart meter data were significantly impacted by Igloo Energy Supply Limited (the energy supplier partner in this project) becoming insolvent in September 2021. The coaching component could not be delivered as intended or access updated energy consumption, leading to reduced functionality (for example less specific or personalised tips being provided) being offered over a shorter duration.

Evaluation approach and methodology

The Competition appointed a separate Trial Design and Evaluation Lead (TDEL) team, led by Ipsos, in conjunction with Energy Saving Trust, Manchester Metropolitan University and the University of Edinburgh, to conduct an independent evaluation of the overall Competition and separate evaluations of each of the individual products and services trialled through the Competition.

This trial-level evaluation sought to test whether the SENS MEETS product was successful in realising its primary objective of reducing gas consumption and what features of the intervention led to more prominent energy savings.

This trial evaluation employed a Randomised Controlled Trial (RCT) design, whereby eligible households who had already received the baseline smart meter consumer proposition (i.e. a smart meter installation, access to near real time feedback on gas and electricity used via an IHD, and energy efficient advice delivered at the point of installation) were randomly assigned to an intervention group, which in addition to the above received the SENS MEETS intervention, or to a 'control' group, who did not receive the SENS MEETS intervention. The trial took place between August 2020 and March 2022, with 932 trialists recruited to the intervention group and 944 recruited to the control group. Signing up to take part in a SENS trial was entirely voluntary, and consent could be withdrawn at any time without giving a reason.

After trial completion, the two groups were statistically compared to quantify the effect of the packaged intervention upon energy consumption. Gas consumption data was collected before and during the trial period through smart meters, with consent from each trialist, and was used to analyse any changes in consumption before and after the SENS MEETS intervention, using a regression framework including the trial group (control or intervention) as a grouping variable, and prior consumption as a control variable.

The analysis was supported by a package of wider research activities including a baseline and endline telephone survey (with intervention and control group trialists) to understand and evaluate their attitudes towards energy, energy usage and management behaviours, uptake of energy efficiency measures, views of smart metering and engagement with the trial. Finally, qualitative interviews were conducted with 15 trialists from the intervention group. Recruiters ensured the inclusion of a range of demographics and perspectives, and interviews covered topics including how trialists interacted with the components of the intervention, their initial experiences and behaviour changes, and longer-term impacts.

Outcomes for trialists trialling the product

The energy consumption analysis (Intention to Treat, and Treatment on Treated) did not show any statistically significant difference between SENS MEETS intervention and control group trialists for gas consumption savings. However, due to several external challenges, related to COVID-19 and wider retail market, the trial underwent considerable changes which meant the intervention package could not be delivered as initially intended (in terms of nature and duration of intervention delivery).

Trialists' responses to the telephone survey and interviews showed that the intervention did not contribute to improving their individual perception of home comfort. However, this might partially be explained by the fact that most trialists already felt they were keeping their homes at a comfortable temperature. Similarly, the majority of trialists believed that they were already managing their energy bills well. However, several trialists had the perception of not being able to keep up with their household energy bills as well as in previous years, likely due to wider energy price increases.

Overall, based on the survey responses, the intervention was not perceived to contribute to changing trialist behaviour at home (e.g. changing heating patterns in unoccupied rooms), although it did appear to moderately improve trialists' knowledge and understanding of their energy use. This was supported by the interviewees' responses, indicating that trialists in the intervention group had a deeper understanding of patterns in their energy consumption, due to the use of the temperature logger, receipt of their heating reports and coaching messages during the trial. However, this did not necessarily translate into a reduction in energy consumption, possibly due to the changes in the intervention delivered.

In terms of feedback on the coaching, most interviewees found the coaching simplistic, which was partially expected as a result of changes to the original coaching approach made following access to live smart meter data being discontinued. Trialists said they were either already aware of the measures they could take to reduce their energy consumption or were relying on smart thermostats to maintain the desired temperature at home.

Conclusions

Ultimately, a robust quantitative assessment of energy savings could not be made, and the evaluation was unable to provide definitive evidence that the SENS MEETS product did or did not impact upon energy consumption savings.

The challenges, related to COVID-19 and the wider retail market, led to several operational challenges, including; a lower than expected number of customers eligible for recruitment; a slower and reduced recruitment including where customers had not previously provided consent at installation to collect half-hourly smart meter data (necessary to deliver MEETS); a lower than anticipated uptake of components (e.g. several trialists in the intervention group did not order a logger or send back the data collected by the logger); and changes in the coaching component which could no longer be delivered as intended i.e. personalised and of expected duration.

Igloo Energy Supply Limited becoming insolvent during the trial likely had the strongest impact on the delivery of MEETS. It affected trial recruitment, which - prior to this - was progressing well, and also meant that the personalised coaching component (informed via accessing half-hourly smart meter data), which was expected to have had the biggest impact on gas consumption savings, could not go ahead as planned. The changes from personalised to generic coaching reduced the expected effect size to be achieved (also meaning that a higher sample size, than originally calculated, would have been required in order to detect any impact).

However, despite these challenges, and although no detectable effect of the SENS MEETS intervention was observed during the analysis upon gas consumption, the intervention appeared to have had an effect on trialists' perception of their own energy use at home in terms of increased understanding. Furthermore, most trialists were satisfied with the SENS MEETS product and could appreciate the value of this kind of intervention.

1 Introduction

The Smart Energy Savings (SENS) Innovation Competition (from here on referred to as ‘the Competition’), led by the former Department for Business, Energy and Industrial Strategy (BEIS), committed up to £6.25 million to support the development, trialling and evaluation of innovative feedback products and services that use smart meter data to help domestic consumers reduce their energy consumption.

Following a competitive application process, eight projects were selected to receive Phase One Competition (matched) grant funding to support the development of their products and/or service. Following a stage-gate review process, five projects were taken through to Phase Two, to trial and evaluate their products and/or services in homes across Great Britain. The Competition was launched in February 2019, with trials concluding at the end of March 2022 (extended by one year due to COVID-19 impacts).

Ipsos, in partnership with Energy Saving Trust, Manchester Metropolitan University and the University of Edinburgh were commissioned by BEIS as the Trial Design and Evaluation Lead (TDEL), to undertake an independent evaluation of the Competition, including separate trial evaluations for each of the individual projects, and to implement a wider package of research. Separately, BEIS awarded a grant to the Smart Energy Research Laboratory (SERL) based at University College London (UCL), for the collection and provision of secure access to energy consumption data from trial households (with trialist consent) to the TDEL for their analyses. BEIS also appointed an independent Project Management lead, AECOM, to oversee the Competition Partners’ project delivery and grant funding milestones.

This report is part of a package of reports published for the Competition, including an overarching competition-level evaluation report, a technical evaluation report and five separate trial-level evaluation reports (of which this is one report).

1.1 Purpose of this report

This report presents the evidence from evaluation of the SENS ‘More Effective and Efficient Thermal comfort with smart meter data’ (MEETS) project. The project was taken through to Phase Two of the Competition to trial and evaluate their packaged intervention in real-world households across Great Britain. The report presents an analysis of energy consumption data and other primary and secondary data that were used to answer the primary research question of the SENS MEETS trial (as well as analysis of other secondary outcomes presented in more detail in chapter five), as detailed in the box below.

What is the added gas saving of SENS MEETS's overall package of interventions (including web-app, heating reports, and tailored energy efficiency coaching), over and above the baseline smart meter consumer proposition (i.e. a smart meter, an In-Home Display (IHD), and energy efficiency advice provided at install)?

Subsequent chapters of this report provide a summary of the SENS MEETS packaged intervention and trial design (chapter two), and the trial evaluation methodology (chapter three). The overall evaluation findings relating to the primary outcome are presented in chapter four with evidence from the energy consumption analysis, quantitative and qualitative research strands. Evidence from the analysis of secondary outcomes is presented in chapter five. Finally, chapter six presents the key conclusions from the trial evaluation.

2 Summary of Trial

This chapter introduces the SENS MEETS intervention, including its core functionality and mechanisms for behaviour change as presented through its Theory of Change. The core features of the trial design are also presented.

2.1 The SENS MEETS intervention

The SENS MEETS intervention was delivered by Lightbulb ES Limited (herein referred to as Lightbulb), the parent company of the former energy company Igloo Energy Supply Limited (herein referred to as Igloo), in partnership with Build Test Solutions Limited and UCL Energy Institute.

As summarised in Table 2.1 below, the purpose of the SENS MEETS project was to deliver SENS MEETS’s three-part package to households, delivered primarily through an online web and mobile-based application, a heating report and coaching messages and emails that better supports households’ control of heating in the home.

Table 2.1: SENS MEETS delivery partners and product description

Project Title	Competition delivery partner(s)		SENS product
	Lead	Partner(s)	
More Effective and Efficient Thermal comfort with Smart meter data (MEETS)	Lightbulb ES Limited (former parent of Igloo Energy Supply Limited)	Build Test Solutions Limited, University College London (UCL) Energy Institute	<p>A three-part package to trialists, delivered primarily through an online web-based application, a heating report and email and SMS notifications:</p> <p>The first part – ‘Me and My Home’ online application – presented trialists with an online picture of their gas and electricity consumption using smart meter data in combination with an existing data platform owned by Igloo Energy Supply Limited.</p> <p>Trialists were then offered a temperature logger which gathered data on patterns of heating within the home, resulting in a household heating report that summarised performance of the building and heating system (using smart meter and internal temperature data),</p>

Project Title	Competition delivery partner(s)		SENS product
	Lead	Partner(s)	
			<p>benchmarked against comparator homes and recommended measures to reduce energy consumption and carbon emissions.</p> <p>Finally, households received a package of coaching and tips on more effective heating control based on the home performance and external weather temperature data, delivered via email/text message (SMS).</p>

2.2 Aims of the SENS intervention and how it was expected to achieve these

Several primary and secondary objectives were identified at the outset of the trial that have been explored in this report (see Table 2.2 below). The mechanisms for realising these outcomes are presented overleaf. This information is also summarised in the Theory of Change diagram presented in Annex A.

Table 2.2: Primary and secondary objectives of the SENS MEETS intervention

Primary / Secondary	Outcomes to be evaluated
Primary	Reduction in gas consumption
Secondary	Changes in electricity consumption, assessed to see any spill over effect
	Improved individual perceptions of home comfort
	Improved household budgeting
	Reduced unoccupied heating hours

Primary / Secondary	Outcomes to be evaluated
	Increased understanding of energy use and drivers of energy consumption

The core functions of the SENS MEETS intervention were as follows:

- **Component 1 – ‘Me and My Home’ (M&MH; delivered between August 2020 and September 2021):**

All trialists were invited to complete a ‘Me and My Home’ (M&MH) profile on the self-service portal as part of their initial registration to Igloo as their energy supplier. This invitation was by way of an email reminder and/ or a splash screen (i.e. a graphical element used to notify users on digital devices) encouraging households to complete their profile when they logged in. The M&MH profile page then requested basic details on the trialists’ homes such as their heating system, household characteristics and appliances.

The data processing system, owned by Igloo, – the Igloo Customer Engine (ICE) – stored this data and linked it to meta data from the Energy Performance Certificate (EPC) database, Land Registry, and census statistics to build a full picture of the drivers of an individual household’s energy consumption. The ICE was also able to segment consumers and build predictive models of the impacts of energy efficiency interventions.

At this point, data was used to select an appropriate ‘benchmark’ comparator, i.e. an average home of similar size, type, age, and location, and generic, one-off energy saving recommendations were provided. If a household did not provide house type or size, they received an average for their location.

The M&MH component was delivered at the beginning of the trial to trialists in both the intervention and the control group, meaning the control group was provided with some additional energy advice compared to the typical consumer. However, the advice was generic and similar to the advice provided to customers at installation of their smart meter.

- **Component 2 – Temperature logger and heating report (delivered between October 2020 and February 2022):**

The temperature logger gathered data on patterns of heating within the home (temperature and humidity), enabling the thermal performance of the home to be estimated. For an example of how thermal performance was estimated, see BEIS’ Smart Meter Enabled Thermal Efficiency Ratings (SMETER) project.³ A USB temperature logger was posted to consented intervention group trialists and occupants

³ <https://www.gov.uk/guidance/smart-meter-enabled-thermal-efficiency-ratings-smeter-innovation-programme>

were asked to place it on their thermostat for a three-week period. After this period, trialists were asked to return the logged data via a third-party app and an email.

Temperature data was gathered to understand heating patterns, measure building heat loss (or Heat Transfer Coefficient, HTC) and estimate heating system performance. A single heating report was emailed to all the households that returned the logged data. The M&MH and EPC data, where available, along with the temperature data were used to provide simple feedback to households on their current energy performance, as well as make recommendations for carbon savings (ranging from low/ zero cost actions like getting a smart thermostat, to more expensive options, such as wall insulation and installing heat pumps and solar panels).

- **Component 3 – Coaching (delivered between December 2021 and March 2022):**

Based on an understanding of the household thermal performance (measured through the M&MH profile and logged temperature data, where available), individual tailored coaching emails were sent to households to provide insights on how their property compared to ‘similar’ properties in terms of average temperature set-points for heating systems and offering tips on how to maintain a lower target temperature while maintaining thermal comfort.

Messages were sent between mid-December 2021 and the end of March 2022 to the 265 trialists in the intervention group who had successfully ordered and received a temperature logger, returned their data, and obtained a heating report. By linking to data on weather forecasts, households also received coaching messages notifying them of upcoming changes in external temperature and tips on how to manage the heating within the home to achieve similar levels of thermal comfort despite any weather changes. Each trialist received an average of six SMS messages or emails over the coaching period, with a minimum of one and a maximum of seventeen, 95% of which were based on upcoming changes in external temperature based on weather forecasts.

Initially the plan was that the intervention would have tailored the content of the coaching messages even further at this point based on live half-hourly smart meter data, which would have been used to develop models, estimate occupancy, provide specific advice on timer settings, monitor the impact of the coaching itself and complete a reinforcement learning loop. However, as this was not feasible (see section 2.3.3), a generic SMETER⁴-based approach was used. This matched trialists to models based on smart meter and temperature data gathered historically from the previous winter (2020/2021). While this approach had some advantages, e.g. the ability to complete the trial without the need to re-consent the trialists, it led to less specific coaching messages and the inability to monitor success and give real-time feedback.

The number of intervention group trialists who received each component of MEETS is summarised in Table 2.3 and in Annex B. Overall, 932 trialists were recruited to SENS MEETS, out of which 96% completed (at least partially) their ‘Me and My Home’ profile, 64%

⁴ <https://www.gov.uk/guidance/smart-meter-enabled-thermal-efficiency-ratings-smeter-innovation-programme>

ordered and received a temperature logger, 34% returned their logged data, 33% received the heating report and 28% received coaching messages.

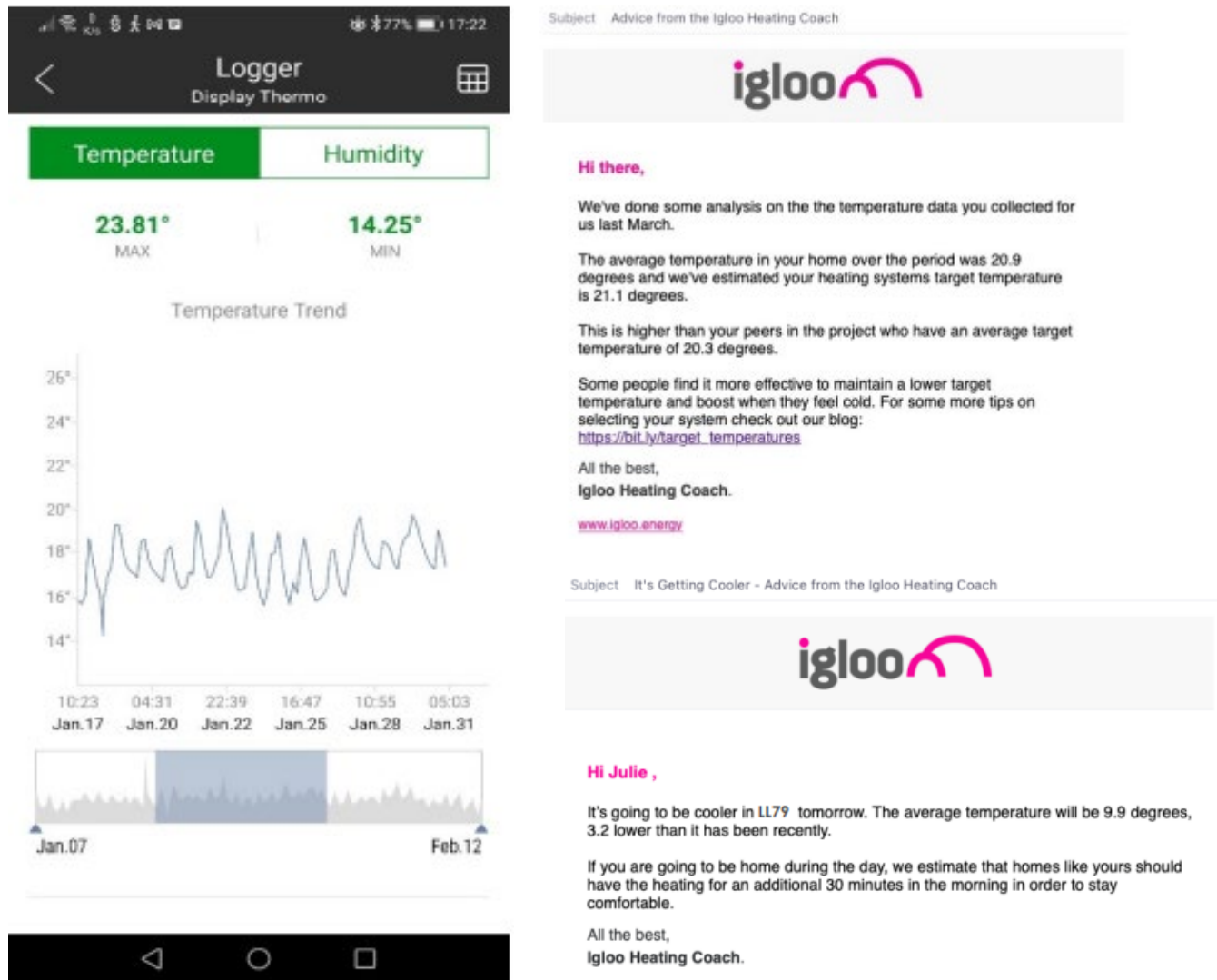
Table 2.3: Changes to the SENS MEETS intervention and rationale

SENS MEETS component	Number of trialists	Time frame
'Me and My Home' (at least partially completed)	891	August 2020 – September 2021
Received heat logger	598	November 2020 – December 2021
Returned heat logger data	313	January 2021 – February 2022
Received heating report	304	March 2021 – February 2022
Received coaching messages, i.e. all intervention components as delivered.	265	December 2021 – March 2022

After completing their M&MH profile, and as SENS MEETS trialists gained greater access to advice about how to save energy in the home, it was anticipated that they would begin to take small but immediate steps to reduce their energy consumption. Subsequently, upon receipt of the heating report, households were expected to develop a better understanding of their home's efficiency, which would enable them to make informed decisions about how to optimally heat their home. The energy efficiency recommendations provided through the heating report were further intended to raise individuals' awareness of the types of measures that could be installed in the home, as well as better inform individuals on the expected payback periods. The coaching element of the intervention was intended to provide additional energy saving advice and encourage participants to consider and adjust their heating use.

Figure 2.1 shows examples of data logged through the logger, and coaching tips received by trialists in the intervention group.

Figure 2.1: Examples of information presented through the MEETS temperature logger and coaching emails



As households made use of the improved access and level of information, it was anticipated that their behaviour regarding their energy use would change in the following ways:

- Reducing wasteful use of energy – e.g. shifting to only heating rooms that were in use, heating only to the minimum temperature required for comfort, and avoiding heating the house when unoccupied.
- Installing energy efficient measures in the home, e.g. double glazing, insulation or a more efficient boiler system.

Such behaviour changes were expected to lead to several outcomes:

- Increased comfort (as a result of setting the desired temperature based on external temperature information).
- Reduced gas consumption.

- Improved understanding of energy use and drivers of energy consumption.
- Improved household budgeting.

For these outcomes to materialise, a number of assumptions needed to hold true during the trial period. Firstly, the advice and recommendations provided through the heating report and coaching emails needed to be accurate and appropriately tailored to the individual households. Secondly, households needed to believe the average comparator was meaningful and relevant. Thirdly, households needed to be motivated to act in response to the data shown. In addition, households needed to understand all recommendations and advice given, as well as being financially and materially capable of acting upon them (e.g. boiler replacement, fabric upgrades). These assumptions have been tested as part of the evaluation of our analysis of the SENS MEETS's contribution to the intended outcomes. Annex A visually summarises the Theory of Change and shows how the product had intended to achieve the outcomes mentioned above.

2.3 Design of the SENS MEETS trial

2.3.1 Randomised Control Trial

To test the effectiveness of the SENS MEETS's packaged intervention in reducing gas energy consumption, the TDEL recommended a Randomised Controlled Trial (RCT), considered the most reliable and stringent design to test the effect of an intervention on the outcome of interest. This approach involved randomly assigning trial households, who had all received the baseline smart meter consumer proposition (i.e. a smart meter installation, access to near real time feedback on gas and electricity used via an IHD, and energy efficient advice delivered at the point of installation), either to an intervention group who received the SENS MEETS intervention, or to a 'control' group, who did not receive the SENS MEETS intervention.

During the trial, control group households were exposed to one of Igloo's Business as Usual (BAU) tariffs, with no access to the heating report and/ or coaching advice offered as part of the SENS MEETS intervention. Control group households did receive a one-off simple energy efficiency advice based on the answers they provided in the M&MH service. However, the advice given to households in the control group did not differ substantially from the guidance all households receive upon installation of a smart meter.

2.3.2 Eligible trialists

The sampling frame for the trial included all dual fuel households within Igloo's customer base who had already had a smart meter installed. The sample frame initially included only customers who had a second-generation smart meter (Smart Metering Equipment Technical Specifications 2; SMETS2) and had an existing data preference of half-hourly reads. As recruitment progressed and the size of the available pool of suitable trialists decreased, the sample frame expanded to include first generation smart meters (SMETS1) Data Communications Company (DCC) enrolled customers, and SMETS2 customers that did not have an existing data preference of half-hourly meter reads but were then invited to.

Customers were required to be DCC enrolled so that their smart meter data could be collected for trial evaluation purposes.

2.3.3 Recruitment strategy

As the energy supplier, Igloo led the recruitment of trialists into the SENS trial including developing the recruitment materials and the format of the consent form (using standardised opt-in consent forms that were General Data Protection Regulation (GDPR) and Smart Energy Code (SEC) compliant, developed by UCL and TDEL), which was delivered via the Igloo Self-Service Portal. Once the materials were agreed and finalised, Igloo sent regular batch recruitment emails to all eligible trialists between September 2020 and September 2021 to invite them to participate in the SENS trial.

Signing up to take part in a SENS trial was entirely voluntary, and consent could be withdrawn at any time without giving a reason. To assess the primary aim of the project, trialists gave opt-in consent to provide access to their smart meter data for the evaluation, using a virtual 'secure lab' analysis environment (Smart Energy Research Laboratory – SERL), provided by UCL. This smart meter data was used by the TDEL and UCL solely for the evaluation. More information on the approach to obtaining trialists' consent is provided in the accompanying Technical Report.

Half-hourly smart meter data were required by Lightbulb to deliver the coaching component of the SENS MEETS intervention. Igloo customers that were a SMETS2 customer and who had consented to providing Igloo with access to their half-hourly smart meter data were provided with an email link to opt-in to the trial, at which point they provided the various opt-in consent permissions to be onboarded onto the trial. At least three follow-up emails were also sent to those who had not responded to the initial invitation. Initial recruitment emails were sent on a fortnightly basis to ensure a steady flow of onboards to the trial. To expand the recruitment pool, Igloo customers that were SMETS1 DCC enrolled or SMETS2 customers who had not previously consented to providing Igloo with access to their half-hourly smart meter data were then approached to consent half-hourly reads, before being invited to join the SENS trial.

As an added incentive to take part, trialists who took part in SENS MEETS were given entry into a £1,000 prize draw to win an energy bill credit.

Once trialists opted-in to the trial via the Igloo Self-Service site, randomisation⁵ into the intervention and control group occurred (see Figure 2.2 overleaf for an overview of the trialist journey and chapter three for more information on the allocation process). Once every household had registered and signed up to the trial, all households proceeded to the regular cycle of monthly billing, irrespective of intervention or control group, or completion of the M&MH service.

At the beginning of the trial, TDEL estimated planned recruitment targets that would meet the sample sizes needed to detect an impact from the SENS MEETS intervention (based on the originally planned intervention package). Based on an anticipated 4.6% reduction in gas

⁵ Lightbulb were responsible for implementing the random allocation.

consumption during the trial, estimated from previous studies⁶ and from the expected percentage of uptake of each intervention component, along with the amount of variability in gas consumption that could be explained by pre-trial consumption data, it was calculated that the trial would need to recruit and retain 1,052 households in both the intervention and control groups. To account for an assumed 25% drop out rate (average number of households switching energy supplier, moving home within a 12-month period or actively withdrawing from the trial), the initial recruitment targets were therefore set at 1,403 households in both the intervention and control groups (Table 2.4).

⁶ https://www.ecs.soton.ac.uk/research/intelligent_energy_management
<https://eprints.soton.ac.uk/358965/1/paper.pdf>
<https://www.bi.team/publications/evaluating-the-nest-learning-thermostat/>
<https://nest.com/-downloads/press/documents/energy-savings-white-paper.pdf>

Figure 2.2: SENS MEETS trialist customer journey

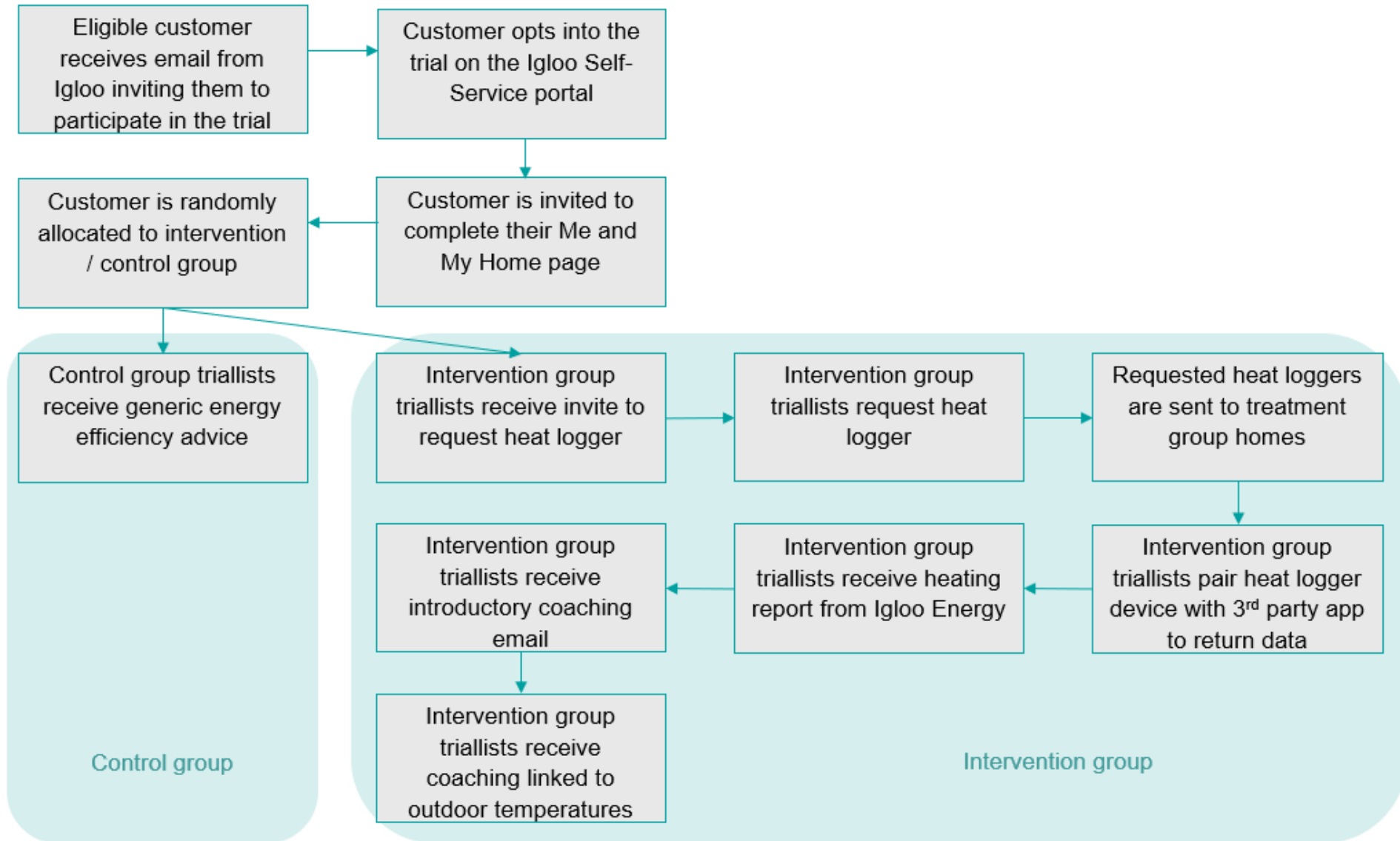


Table 2.4: Recruitment targets versus achieved recruitment figures

Trial	Trial design	Recruitment target (intervention / control) initially set out by the TDEL	Recruited to the trial (intervention/ control)	Number of withdrawals / missing data (up to end of March 2022; intervention / control)	Final achieved sample (intervention / control)
MEETS	Randomised Controlled Trial (RCT)	1403/1403	932/ 944	190/167	742/777

Due to various challenges, including COVID-19 impacts and changes in the wider retail market (see SENS Evaluation Competition Report), the SENS MEETS trial did not achieve the number of recruited trialists as initially planned. These challenges included:

- **Limited pool of eligible customers:** Due to the COVID-19 pandemic impact upon the Competition, there were fewer eligible customers than anticipated eligible for recruitment.
- **Extended recruitment process for households without half-hourly consent:** In order to deliver the SENS MEETS intervention, customers that had not already provided Igloo with consent to access their half-hourly smart meter data were approached to go through a two-step approach to provide it. This led to a lower sign-up rate compared to those that had already consented to share this.
- **Igloo Energy Supply Limited entered administration:** Igloo Energy Supply Limited ceased trading at the end of September 2021 and went through the Supplier of Last Resort (SoLR) process.⁷ The collection of consumption data for the evaluation via SERL was then paused, but later resumed after approval from the Smart Energy Code Administrator and Secretariat (SECAS) (to backfill during pause period and to collect up until end of trial, end March 2022). Igloo customers moved energy suppliers but were updated on the project status about the fact that they could still remain in the Lightbulb SENS trial if they wanted to (up to end March 2022). This may have influenced the end of trial survey and interview responses (conducted in January to March 2022) and contributed to the delays and uptake issues above.

⁷ <https://www.ofgem.gov.uk/publications/igloo-energy-supply-limited-provisional-order> - Suppliers that go through SoLR process were subsequently unable to access their customers' energy consumption data due to the SoLR process that repeals consent previously provided by customers to access this data.

These challenges led to a reduction in the number of trialists retained than initially planned, along with changes to the intervention packaged delivered. Overall, these challenges were expected to reduce the anticipated effect size:

- **Product recommendation intervention not delivered, after Igloo Energy Supply Limited went into administration:** In the original plan developed at the start of the Competition, Igloo initially planned to analyse trialists' data from their M&MH profile, temperature logger and other meta data sources to identify those who were likely to benefit from a smart thermostat. These trialists would then receive an offer to purchase a smart thermostat. This part of the intervention was estimated to reduce gas consumption and by not delivering it, the anticipated effect of the SENS MEETS intervention was expected to decrease significantly compared to initial effect size assumptions.
- **Delays and low uptake of heating reports and coaching:** The original plan assumed there would be 50% uptake of the temperature logger and coaching interventions. Despite 64% (N = 598) of retained intervention group receiving a temperature logger, only 34% (N = 313) returned their logged data, and 33% (N = 304) received a heating report for their home. Of those that received a heating report, 65% (N = 197) were delivered near the end of the heating season (January/February 2022). Similarly, only 28% (N = 265) of the intervention group received coaching messages, all between December 2021 and February 2022. Lower uptake rates and delays in delivering these interventions reduced the number of trialists receiving the interventions and the time available to change their consumption habits, reducing the magnitude of the effect size observable through the trial.
- **Quality and personalisation of the coaching tips:** The original design of the intervention envisioned using live half-hourly smart meter data to provide tailored coaching tips, estimate impact and provide feedback to householders. However, customer's smart meter data could not be accessed after Igloo entered administration, and an alternative approach based on models trained on external temperatures and historical smart meter data collected in Winter 2020/ 2021 was used, leading to more generic coaching tips, delivered over a shorter period of time.

Taken together, these changes had an effect on the estimated expected impact of the intervention on gas consumption and on the robustness of the trial, reducing both. A higher sample size than originally calculated would be required to detect any expected effect sizes of the intervention delivered. Table 2.5 summarises the main changes to the delivery of the SENS MEETS intervention, the rationale determining such changes and their likely impact.

Table 2.5: Changes to the SENS MEETS intervention and rationale

Rationale	Changes to intended intervention	Likely impact
<p>As the coaching aspect of the intervention was intended to provide coaching on how to use recommendations, when Igloo Energy Supply Limited entered administration (removing any ability to access household smart meter data from then on), the coaching aspect pivoted, removing the rationale for delivering the product recommendation.</p>	<p>Product recommendation, i.e. the offer of a new smart thermostat, did not materialise.</p>	<p>The expected effect of the SENS MEETS intervention on gas consumption decreased, given the assumption that the product recommendation would have helped trialists reduce their gas consumption.</p>
<p>Both the COVID-19 pandemic and Igloo Energy Supply Limited entering administration caused delays in the delivery of the intervention and likely impacted trialists' willingness to actively participate and interact with each component of the intervention.</p>	<p>Uptake of each component was reduced and delayed, including ordering the logger, sending logged data, and interacting with the heating reports and coaching tips.</p>	<p>The lower uptake of the intervention components were likely to have contributed to a reduction in each component's effect on reducing gas consumption. Additionally, the delays in the delivery of SENS MEETS reduced the window of time in which trialists could act upon the advice and coaching received.</p>
<p>Half-hourly smart meter data could not be accessed after Igloo Energy Supply Limited entered administration. A more generic SMETER-based approach was adopted.</p>	<p>Coaching could not be tailored based on live half-hourly smart meter data from trialists. As a result, coaching advice was less specific, and no monitoring or real-time feedback was possible.</p>	<p>The anticipated effect of the coaching component was likely reduced due to the coaching tips being less tailored around trialists' live smart meter information.</p>

3 Methodology

This section describes the methodological approach to implementing the Randomised Controlled Trial evaluation design, including the approach to random allocation, data collection methods and statistical methods employed for the energy consumption analysis. More information is provided in the accompanying Technical Report published alongside this report.

3.1 Assignment of intervention

A Randomised Controlled Trial (RCT) design was employed. This used a batch randomisation technique to allocate trialists between the intervention and control group. Once trialists had signed up to the trial and given consent to the various permissions requested, Lightbulb was responsible for generating the allocation sequence for this trial. To ensure that the average energy consumption of the control and the intervention groups were similar and that possible differences in energy consumption between groups detected during the trial were driven by the SENS MEETS intervention, households were divided into smaller groups, before assignment took place. This was based on the customers annual consumption of electricity, as estimated by the supplier, with the bands determined at various consumption levels. After trialists consented, Lightbulb's algorithm retrieved their estimated annual consumption and then checked the count of control and intervention group in the relevant strata and assigned trialists in question to the smaller group or randomly assigned them to either the intervention or control group if the groups were equal.

3.2 Data Collection

The evaluation utilised a range of data sources to provide evidence against the primary and secondary research questions for the SENS MEETS trial (as outlined in Table 2.2).

3.2.1 Energy consumption data

Gas and electricity consumption data was collected (with consent) to cover two periods:

- During the trial: Gas and electricity consumption data was securely provided to the TDEL by the UCL Smart Energy Research Laboratory (SERL), at 30-minute resolution for the trial period. UCL SERL was responsible for managing the collection and provision of smart meter data from trialists with their consent to the TDEL for the purposes of evaluation.
- Before the trial: Gas and electricity consumption data was securely provided to the TDEL by Igloo Energy Supply Limited, using information from quarterly/annual bills and meter readings. This energy pre-consumption data was used as a control variable in the analysis.

3.2.2 Engagement data

Lightbulb securely collected data on how frequently intervention group trialists engaged with the SENS MEETS packaged intervention (based on appropriate consent being in place from the intervention group). Specifically, Lightbulb kept track of how many trialists engaged with each component of the intervention, as listed below. This supported the TDEL in their understanding of how trialists were interacting with the advice and recommendations provided and in evaluating the impact of the intervention at the end of the trial. The types of metrics captured included:

- Whether the individual received the heating logger.
- Whether the individual returned the logged data.
- Whether the individual received a heating report (including date received).
- Whether the individual received any coaching recommendations (including date of receipt and nature/content of coaching email).

3.2.3 Quantitative telephone survey with trialists

Intervention and control group trialists were all invited to take part in a baseline and endline telephone survey. The baseline survey took place between December 2020 and December 2021 and recorded responses from 352 trialists in the intervention group and 346 in the control group. The endline survey was conducted in March 2022 and surveyed 117 trialists in the intervention group and 141 in the control group (see Annex B). The survey questions covered attitudes towards energy, energy usage and management behaviours, uptake of energy efficiency measures, views of smart metering and engagement with the trial. While most questions asked in the baseline survey were repeated in the endline survey to allow for comparisons, about a quarter of the questions were changed to investigate product interaction. More details on the timings and key topics explored by the telephone survey are included in the accompanying Technical Report.

One sample t-tests between baseline and endline survey percentages were conducted for the survey findings at the Competition level only (aggregated across all trialists) but not at individual trial level, to determine whether the change was statistically significant at conventional significance levels. Unless explicitly stated, any reported changes (baseline to endline) are indicative only and have either not undergone statistical significance testing or were not found to be statistically significant.

3.2.4 User in-depth interviews

TDEL conducted qualitative interviews with 15 trialists in the intervention group who had been given access to the SENS MEETS packaged intervention over the trial period. These were recruited from those who completed the endline surveys so there is some overlap with survey responses.

The interviews were semi-structured and typically lasted 45-60 minutes. The topics covered included: if and how the trialist had engaged with the SENS products throughout the trial period; trialists' views and experiences of the SENS products and their perceived impact upon day-to-day behaviours and energy usage; and any changes in secondary evaluation outcomes (beyond energy consumption savings explored through the energy consumption analysis), such as improved household budgeting, improved thermal comfort, and attribution of these changes to participation in the SENS trial. A range of quotas across different demographics and household characteristics were sought, covering householder age, property age and income. Further details of this can be found in the Technical Report.

3.3 Data analysis

3.3.1 Data quality and cleaning

Initial data cleaning was conducted on the data where required, as follows:

- Energy Consumption Data – before the trial. The pre-baseline electricity and gas (Estimated Annual Consumption (EAC) and Annual Quantity (AQ)) annual usage estimates provided by the Competition Partner were converted to a daily mean by dividing by 365, to match the units used for the evaluation period energy consumption data.
- Energy Consumption Data – during the evaluation period. Mean daily estimates of electricity and gas use were calculated for each trialist's participation period using the available smart meter data for their properties. Smart meter data were cleaned and used to produce the estimates following an approach similar to that used by SERL for its data and statistical releases (see Elam, Webborn et al., 2022, and Few, Pullinger et al., 2022⁸). The approach is described in more detail in the Technical Report.

3.3.2 Statistical analyses of energy consumption

Analysis of the primary outcome, i.e. the change in gas consumption before and after the SENS MEETS intervention, was tested using a regression framework (analysis of covariance – ANCOVA) including the trial group (control or intervention) as a grouping variable. The framework included prior consumption in the baseline model as a control variable along with others such as Index of Multiple Deprivation (IMD) Quintile.⁹ The impact estimator of the

⁸ Elam, S., Webborn, E., McKenna, E., Oreszczy, T., Anderson, B., Few, J., Pullinger, M., European Centre for Medium-Range Weather Forecasts, Ministry of Housing, Communities and Local Government, Royal Mail Group Limited. (2022). *Smart Energy Research Lab Observatory Data, 2019-2021: Secure Access*. [data collection]. 5th Edition. UK Data Service. SN: 8666, DOI: [10.5255/UKDA-SN-8666-5](https://doi.org/10.5255/UKDA-SN-8666-5); Few, Pullinger, McKenna, Elam, Webborn and Oreszczy (2022) Smart Energy Research Lab: Energy use in GB domestic buildings 2021. Variation in annual, seasonal, and diurnal gas and electricity use with weather, building and occupant characteristics. (SERL Statistical Reports: Volume 1), <https://serl.ac.uk/key-documents/reports/>.

⁹ The index of multiple deprivation is the most widely used index that measures relative deprivation in small areas in England (Lower-layer Super Output Areas - LSOA). <https://www.gov.uk/government/statistics/english-indices-of-deprivation-2019>

primary outcome was the average treatment effect (ATE), calculated as the difference between the average daily gas consumption for all treatment and control group trialists.

As a secondary outcome, the intervention effect on electricity consumption was also analysed, using a similar approach to the one detailed above. Details on how the daily gas and electricity consumption was calculated for each household during the duration of the trial are provided in Annex C. The average pre-trial gas and electricity daily consumption estimates were calculated by dividing the annual consumption data (provided by Igloo) by 365. This included the AQ for gas and the EAC for electricity.

The gas and electricity consumption analyses were performed on trialists based on their assigned group (control or intervention) and estimated the effect of the intervention offer (Intention-To-Treat, ITT) regardless of whether they engaged with each component. Alternative models looking at additional predictor variables and specific segments of the trialists pool were evaluated. These included a Treatment-On-the-Treated (TOT) analysis of the effect of the intervention on those trialists who underwent the entire intervention journey and actively engaged with each component of the intervention package. The final number of trialists assigned to either the ITT or the TOT analysis is reported in the trial sample journey in Annex B.

3.3.3 Secondary analyses

Analyses for the secondary outcomes evaluated in this trial, as well as supplementary analyses for the primary outcome, are based on the survey and interview data collected from a sub-sample of the intervention group trialists. Whilst both the baseline and endline surveys were conducted with both control and intervention group trialists unless otherwise stated, survey statistics presented in the results sections are based on:

- for baseline results, responses from 346 trialists in the control group and 352 trialists in the intervention group.
- for endline results, responses from 141 trialists in the control group and 117 trialists in the intervention group.

As these are results based on intervention group trialists from the start and end of the trial, and the endline results are from a subset of trialists from the baseline results, care needs to be taken in their interpretation. For example, there were contextual changes between the baseline and endline that could influence responses and whose effects cannot be excluded, including the fact that the endline was during the heating season whilst many of the baseline surveys were during the non-heating season, and there had been substantial increases in energy prices over the period between the surveys. Discussions of the survey findings in the results presented in chapter 4 highlight these and other factors where relevant.

Qualitative interview data has been used to supplement the survey results where relevant, to give a fuller qualitative insight into the thoughts of trialists around secondary outcomes.

4 Analysis of primary outcomes

This section describes the results of the primary analysis of gas consumption data, comparing trialists in the control versus intervention group and including alternative models such as different potential controlling variables. Survey and interview data provide further context to the results of the energy analysis.

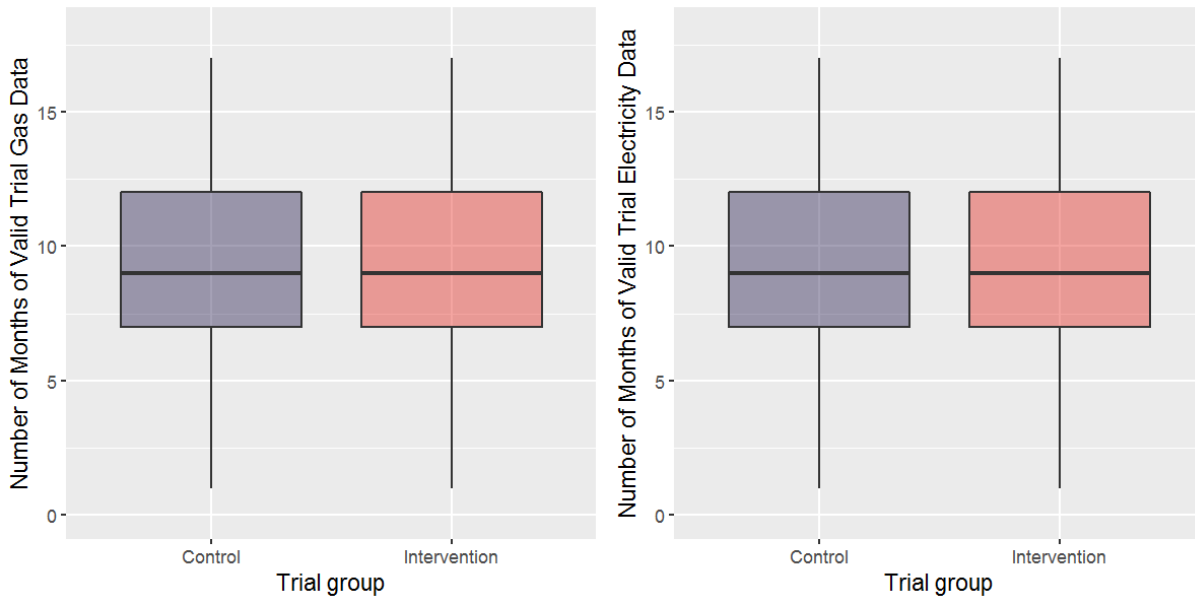
4.1 Summary of available data

Of the original 1,876 trialists whose data were made available into SERL, at the end of the recruitment period (see Table 2.4), only a subset could be retained in the trial and had consumption data in SERL. All trialists that withdrew their consent (357) were excluded from the analysis. These withdrawals included both households that underwent a change of tenancy, a change of energy supplier, and those that actively withdrew their consent, as detailed in Annex B. The final sample used to conduct the primary analysis therefore included 1,519 trialists across the intervention and control groups who had some gas and electricity consumption data available in SERL. After cleansing the data¹⁰ and restricting the analysis to households with more than 50% of valid daily gas consumption readings over the trial months, valid gas daily readings were available for 1,431 homes (730 control, 701 intervention). Similarly, valid electricity daily readings were available for 1,493 homes (762 control, 731 intervention).

The boxplots in Figure 4.1 overleaf show summary statistics of the number of valid months of data that were used for the ITT analysis of both gas and electricity data, across trialists separated by control and intervention group. For both fuels, the number of months of valid data ranges from the minimum of one month to a maximum of 17 months, after excluding outliers, with an average number of valid months of available data of 10 in both groups for both gas and electricity. Differences in the number of months of available data was mainly determined by the fact that trialists were recruited over an extended period of time (August 2020 – September 2021).

¹⁰ Some trialists were excluded either because data was missing or because of unrealistic values and wrong timestamps.

Figure 4.1: Boxplots of the number of months of valid data for trialists in the control and intervention group, for gas and electricity consumption



Figures 4.2 and 4.3 show the distribution of average daily pre-trial and in-trial consumption data, separated by trial group, for gas and electricity respectively. In all cases, the intervention and control distributions look very similar, as do their distribution means, with the average gas pre-consumption being 46.95 kWh/day in the intervention group and 49.09 kWh/day in the control group, and the average in-trial gas consumption being 47.83 kWh/day in the intervention group and 49.4 kWh/day in the control group. Similarly, average electricity consumption figures differed very little between groups, with the average electricity pre-consumption being 13.08 kWh/day in the intervention group and 13.55 kWh/day in the control group, and the average in-trial electricity consumption being 12.82 kWh/day in the intervention group and 13.28 kWh/day in the control group. All averages are reported with their 95% confidence intervals.

Figure 4.2: Distributions of mean pre-trial and in-trial daily gas consumption, by trial group.

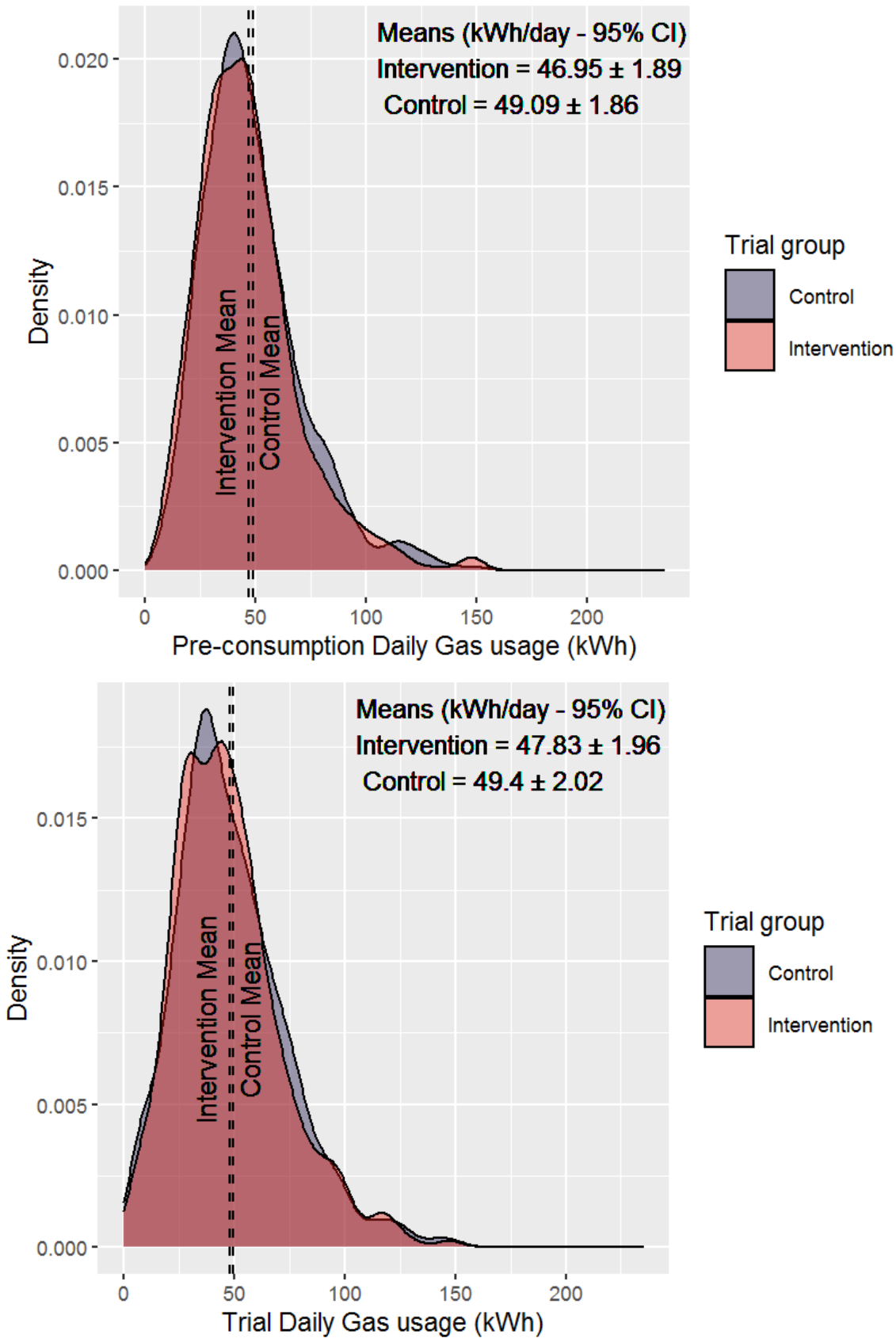
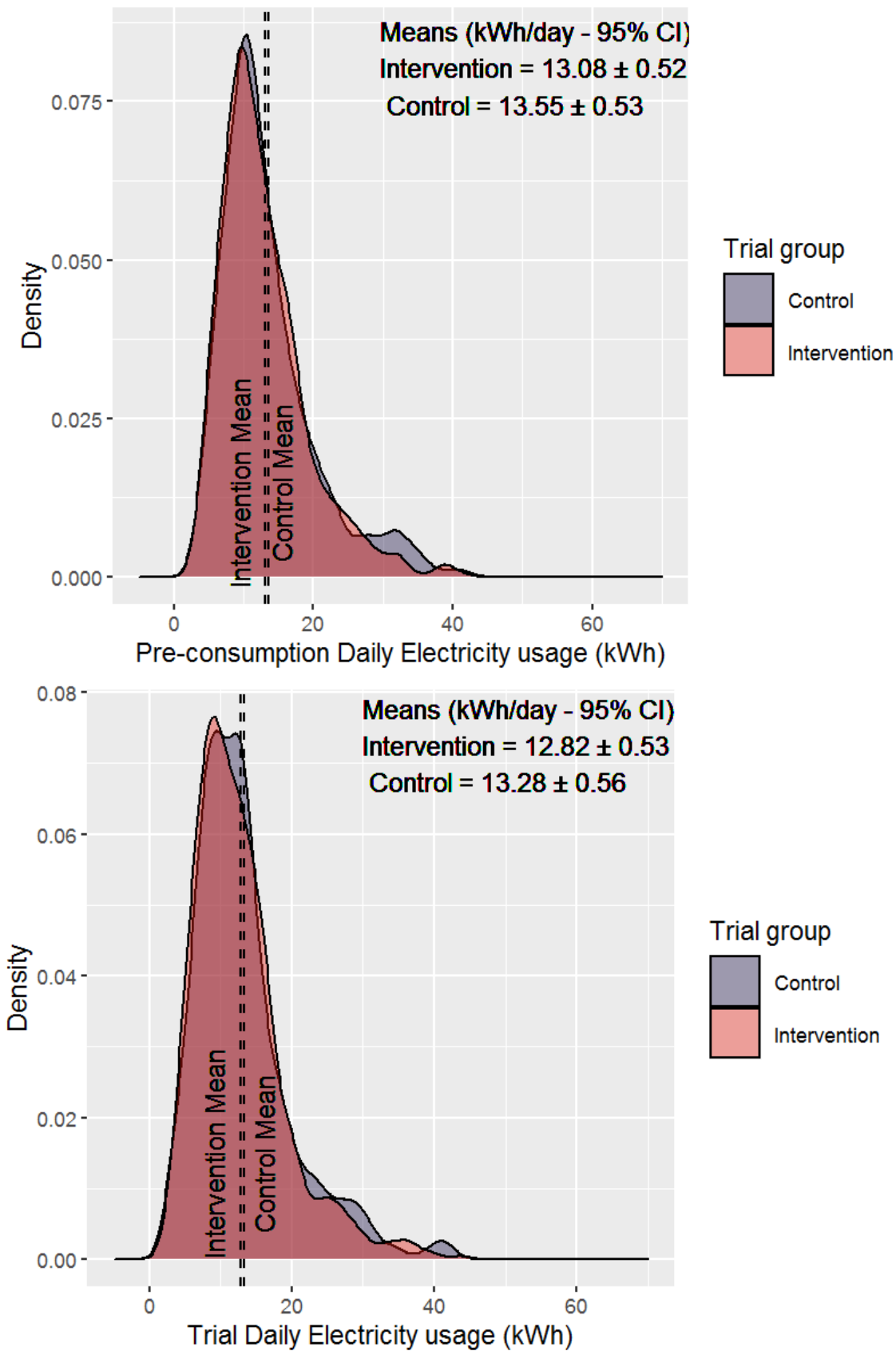


Figure 4.3: Distributions of mean pre-trial and in-trial daily electricity consumption, by trial group.



4.2 Gas consumption results

The ITT analysis of trial daily average gas consumption did not detect a statistically significant difference (at 95% confidence level) when comparing between intervention and control group households. Given the considerable changes that occurred during the delivery of the SENS MEETS intervention, due to the challenges detailed in section 2.2.3, these results were not unexpected.

The ANCOVA analysis regression looked at trial daily average gas consumption against the grouping variable (group; intervention versus control) and the pre-consumption daily average consumption as a controlling variable. Although a difference of 1.57 kWh/day in average daily gas consumption between control and intervention group trialists was observed, this was not found to be significantly different (p-value = 0.81). Including the IMD Quintile as an additional explanatory variable marginally improved the overall explanatory power of the model but did not detect a significant difference between intervention and control group (p-value = 0.85). Most of the variability in the trial daily average gas consumption was explained by the pre-trial consumption data, which was highly correlated with in-trial consumption (Pearson's $r = 0.78$).

4.3 Electricity consumption results

The ITT analysis of trial daily average electricity consumption did not detect a statistically significant difference (at 95% confidence level) when comparing between intervention and control group households. Once again, these results are not unexpected for the reasons detailed in section 2.3.3.

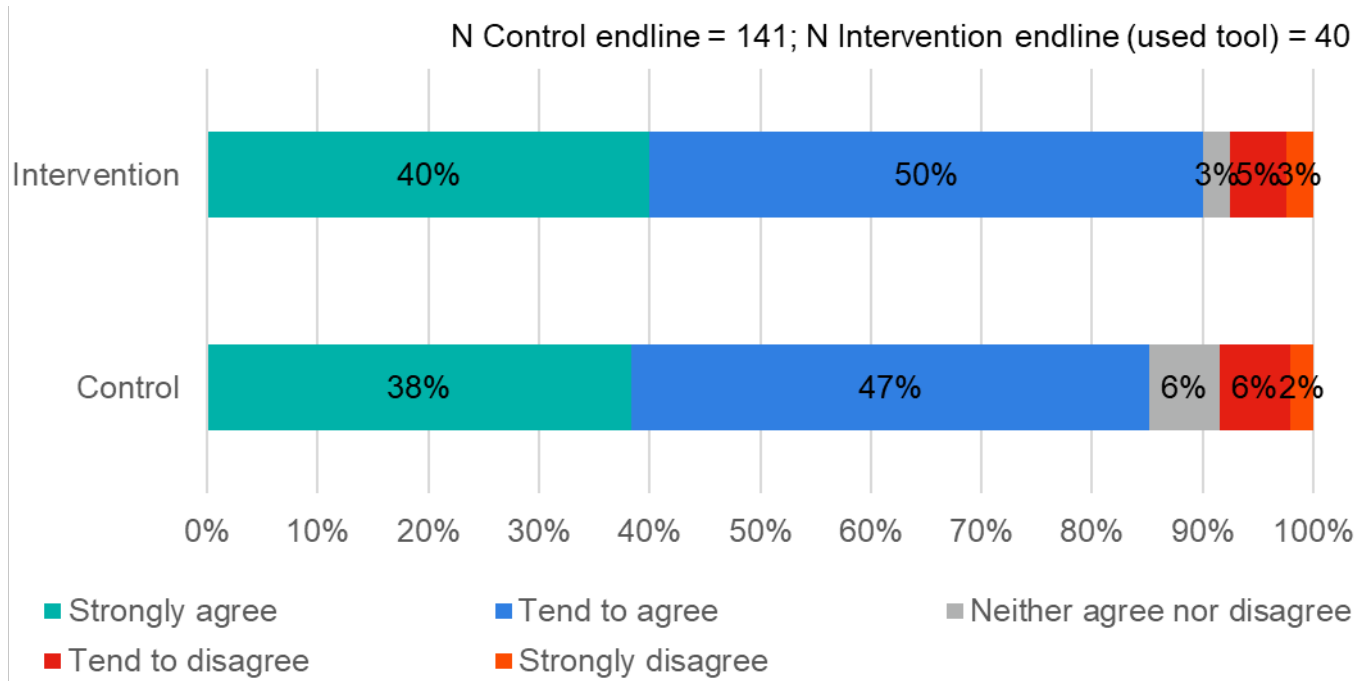
To analyse electricity consumption, an ANCOVA model analogous to the one used for gas consumption was used. A very small difference of 0.46 kWh/day in average daily electricity consumption between control and intervention group trialists was observed, which was also not significant (p-value = 0.86). Once again, the inclusion of the IMD Quintile in the regression led to a marginal improvement of the overall ANCOVA but did not indicate a significant difference between intervention and control group (p-value = 0.85). Similar to gas, most of the variability in the trial daily average electricity consumption was explained by the pre-consumption data, which was found to be highly correlated with in-trial consumption (Pearson's $r = 0.85$).

4.4 Supporting evidence from the survey results

The lack of a detectable difference in gas and electricity consumption between the control and intervention group was in line with the fact that most trialists who participated in the endline quantitative telephone survey (N = 181, 12% of achieved sample) indicated an intention to reduce the amount of energy they used at home, regardless of their assigned group. These included 141 trialists in the control group and 40 trialists in the intervention group who stated that they actively interacted with the intervention components. As Figure 4.4 shows, 90% of intervention group respondents agreed or strongly agreed with the statement that they had

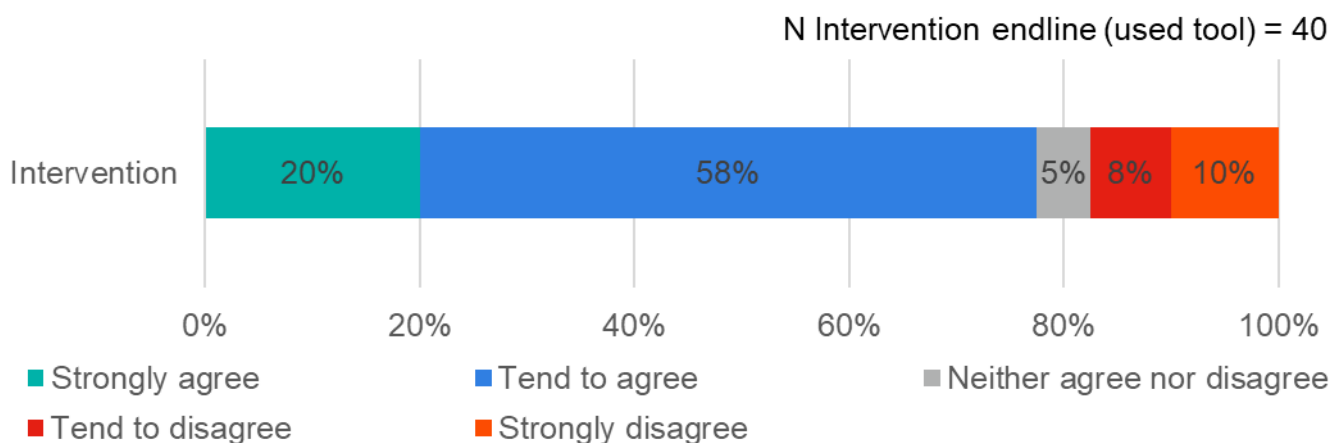
tried to reduce their energy consumption, compared to 85% for the control group. The fact that the two groups expressed similar concerns could be due to the fact that the survey was conducted in Winter, when concern about energy bills and consumption was generally high. However, if both groups were actively trying to reduce their energy consumption during the trial period, then this may have reduced the differential effect size, attributed to the SENS MEETS interventions.

Figure 4.4: Agreement with the statement: “I have tried to reduce the amount of energy I use at home”.



As Figure 4.5 shows, when the question referred specifically to gas consumption, a lower overall proportion of respondents in the intervention group agreed or strongly agreed (78%) with the statement. While these survey results are based on a relatively small sample (N = 40, 5% of achieved intervention group sample excluding consent withdrawals) they do not indicate an increased attempt to reduce consumption (relative to Figure 4.4). This aligns with the finding of no statistically significant reduction in gas consumption and could be due to the considerable changes to the delivery of the SENS MEETS intervention.

Figure 4.5: Agreement with the statement: “I have tried to reduce the amount of gas I use at home since using the product provided”.



4.5 Alternative models

To explore whether certain segments of trialists experienced a stronger effect from the SENS MEETS intervention, a set of alternative models looking at specific subsets of data were built. All ANCOVAs included the same explanatory variables as before, i.e. the grouping factor, and the pre-trial consumption data from Igloo as controlling variables. Each analysis was performed on both gas and electricity consumption daily averages, for the segments defined as follows:

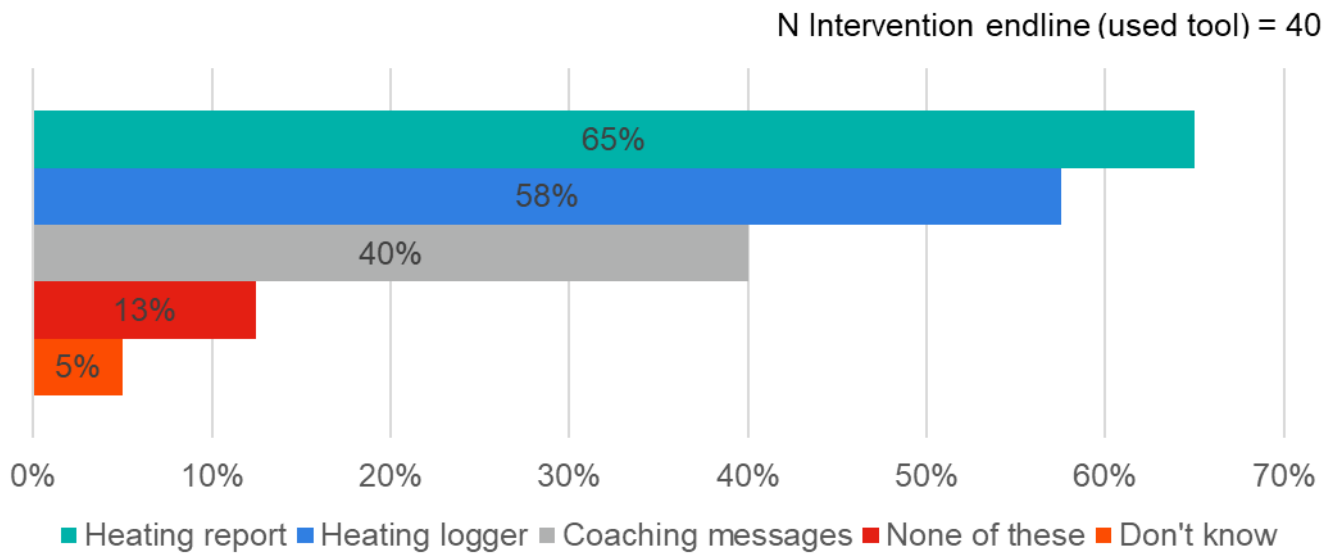
- Trialists with a minimum of 12 valid months of data in both control and intervention groups.
- Trialists with valid data over an entire heating season (October to March, regardless of the year) in both control and intervention groups.
- Outliers removed based on Cook's distance¹¹ being bigger than $4 / N$, with N being the total number of data points in the model, in both control and intervention groups.
- Average daily gas and electricity consumption data estimated based solely on data collected during the heating season (October to March).
- Trialists in the intervention group who received coaching messages and emails. Multiple levels of engagement were possible for each trialist, as detailed in section 2.1. However, since no significant difference in energy consumption between control and intervention was observed across all trialists, potential detectable effects would be expected for those trialists who participated in the entire engagement process, including; completing the M&MH profile; ordering, using and returning the logger; receiving an individual report; and being targeted with coaching messages, particularly when trialists actively interacted with each of these components. Figure 4.6 overleaf shows the proportion of endline surveyed trialists in the intervention group who said they actively interacted with the intervention, by component. Looking

¹¹ Cook's distance estimates the influence of a data point in a least-squares regression analysis.

Cook, R. D. (1977). Detection of Influential Observation in Linear Regression. *Technometrics*, 19(1), 15–18. <https://doi.org/10.2307/1268249>

at this subset of trialists corresponded to a TOT analysis, which focuses on the effect of the intervention on the trialists who actively engaged with the intervention. The gas TOT analysis included 730 trialists in the control group and 252 in the intervention group, while the electricity TOT analysis included 762 trialists in the control group and 264 in the intervention group (see Table 4.1 overleaf).

Figure 4.6: Proportion of respondents in the intervention group who interacted with each engagement component



No sub-model detected a significant difference between the control and intervention group for gas or electricity consumption. This was observed regardless of how long and in which season trialists were in the SENS MEETS trial, and whether they received all components of the intervention.

Table 4.1 provides a brief description of each approach, along with the number of trialists in each group and the p-value associated with the grouping variable (p-values higher than 0.05 indicate no significant difference was detected).

Table 4.1: Primary and secondary outcomes of the SENS MEETS intervention

Sub-model description	Gas consumption: significance of group (N intervention / N control)	Electricity consumption: significance of group (N intervention / N control)
Trialists with min. 12 months of valid data (ITT)	p-value = 0.35 212 / 235	p-value = 0.90 227 / 244

Sub-model description	Gas consumption: significance of group (N intervention / N control)	Electricity consumption: significance of group (N intervention / N control)
Trialists with valid data during the entire heating season (Oct-Mar) (ITT)	p-value = 0.96 649 / 683	p-value = 0.99 684 / 717
Outliers removed based on Cook's distance (ITT)	p-value = 0.96 657 / 694	p-value = 0.84 694 / 702
Daily average consumption calculated on heating season only data (ITT)	p-value = 0.72 680 / 708	p-value = 0.55 715 / 750
Effect of trialist engagement (coaching; TOT)	p-value = 0.54 252 / 730	p-value = 0.96 264 / 762

Insights from the responses to the qualitative interviews conducted at the end of the trial supported the findings from the quantitative analysis. Very few (of the 15 respondents interviewed) reported that participating in the SENS MEETS trial helped them to reduce their energy consumption and managing their bills:

"The tool helped, I have found the information useful and have acted on it."

Some did not identify any material impact in participating in the trial in terms of their household energy use or fuel bills, mostly confirming what they already knew:

"Everything we've done with the boiler, the freezer, things like that have been things we'd have done anyway."

"It confirmed what I have been doing and that the house is at the right temperature. Has it improved things in this house? No, not really."

"Only made very minor impact on us. I hadn't expected an awful lot, but I kind of expected a bit more from it. Maybe they could have got in touch a bit more."

However, half of them did feel more aware of their household energy consumption at the end of the trial:

"It has helped me to appreciate my energy use more than it did before. Maybe not gone far enough to tell me how to improve it but opened my eyes to what is being used and how I am comparing to others in a similar situation."

“It has given me a bit more insight on my household energy use, but not to a great extent. I do think it would be very useful for some people. Like I said, the report was very insightful, and I was impressed with the amount of data that came through.”

Others said that the SENS MEETS intervention simply confirmed what they already knew and did not provide enough novelty in terms of the tips and advice given:

“The tips were quite obvious stuff like keeping windows and doors closed.”

“The feedbacks and hints and tips in particular, they’re obvious and it’s great to be reminded of them, but I’m always hoping that there would be something more significant.”

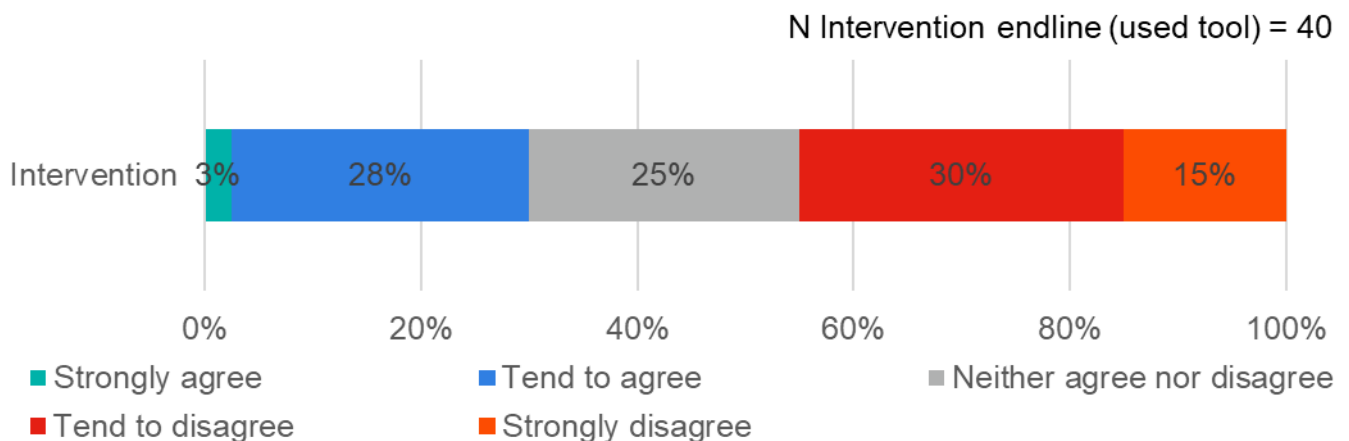
5 Analysis of secondary outcomes

This section describes the results of the analysis of the survey and interview data relating to the evaluation of the secondary outcomes described in chapter two.

5.1 Improved individual perceptions of home comfort

Both the statistical analysis of the primary outcome and trialists' responses to the quantitative survey indicated that the SENS MEETS intervention did not contribute to improving trialists' individual perception of home comfort, described as a householder's perspective of whether they feel too hot or cold at home. As Figure 5.1 shows, three in ten (31%) endline surveyed trialists (N = 40)¹² found it easier to heat their home comfortably after starting to engage with the SENS MEETS packaged intervention, whereas 45% disagreed to some extent.

Figure 5.1: Agreement with the statement: “I have found it easier to heat my home to a comfortable level since I started to engage with the product”.



However, this might partially be explained by the fact that most trialists already felt like they were keeping their homes at a comfortable temperature. At the beginning of the trial, this was found for 94% of the respondents in the intervention group (N = 117) and 89% of respondents in the control group (N = 141), while only 6% of trialists in both groups did not find their home temperature comfortable.

This is further supported by the opinions expressed by the qualitative interview findings with the intervention group at the end of the trial. Out of the 15 interviewees, all of them stated that they had managed to keep their homes comfortable. Some attributed this to their participation in the trial.

¹² This excludes trialists who said in the survey that they had not used the product.

“I mean I don’t really like rooms to be freezing cold, but I have got three bedrooms, two of them I don’t use. I wouldn’t heat those [rooms]. I would close the door and not heat them. That’s probably because of the heating report.”

Others believed that this was due to the latest winter (2021/2022) being warmer than the previous one (2020/2021), along with their existing energy efficiency awareness and the efficacy of their heating systems (e.g. new boilers and programmable thermostats).

“I think it’s easier [to keep the house warm this winter compared to last year]. I feel last year we just kept pressing the boost button a lot more than we do now.”

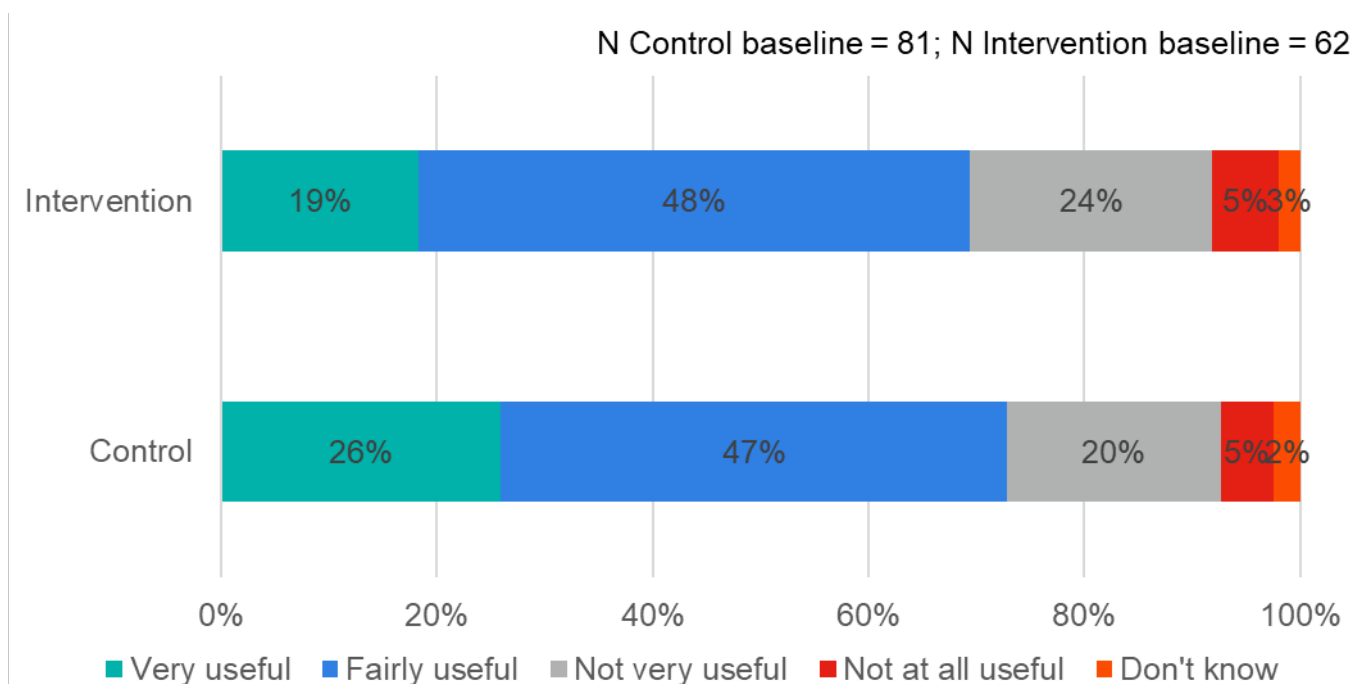
“I have a house smart thermostat which knows when I’m in the house or out of the house so, heating goes off if I’m out of the house, although the heating’s set on a schedule and it just comes on mornings and evenings really.”

“It’s been a much milder winter than last year. But, yeah definitely easier this winter. But partly just because it’s been much milder and partly [because] having the new heating [new boiler] has started making it easier to control.”

5.2 Improved household budgeting

At the beginning of the trial, most respondents who completed both the baseline and endline survey in both the control (73%) and intervention (67%) group indicated that it would be useful for them to know what the typical level of energy consumption was within their household (Figure 5.2).

Figure 5.2: Perception of usefulness of knowing the normal level of energy use within a household (N Control = 81; N Treatment = 62)



A smaller proportion of trialists showed interest in monitoring their spend against a budget, with less than two thirds of respondents to both the baseline and endline surveys in the intervention (62%; N = 45) and control (54%; N = 63) group finding it a useful exercise. This could show less willingness from a fair portion of the trialist pool to actively engage and take advantage of the SENS MEETS intervention. If it had been a colder winter or had the question been posed in April 2022 (as opposed to March), after Ofgem's energy price cap increase¹³, the importance of household budgeting may have been more evident in the survey responses.

These observations could also relate to the overall perception of how well trialists were keeping up with their energy bills. The baseline survey at the beginning of the trial showed that around nine in ten in both the intervention group (91%) and control group (86%) felt that they were already managing their energy bills well. Interestingly, this proportion indicatively dropped slightly towards the end of the trial, decreasing to around two in three (65% and 62%) respectively. It is not expected that this effect is due to the trial intervention. Instead, it might relate to the timing of the trial, which coincided with the end of the heating season and the announcement of the higher UK energy price cap.

Trialists' perceptions of not being able to keep up with their household energy bills as well as in previous years was stressed by several interviewees at the end of the trial. Some felt that although they were mostly in control, their bills were having a worse impact than in the previous winter, and some expressed a deeper concern about the next heating season:

"We are managing fine. We accept that the prices are going up and there is not a huge amount we can do about it."

"I'm having to make a conscious effort to pay bills more than before, because of the recent rise in energy prices. I am careful about how much I spend."

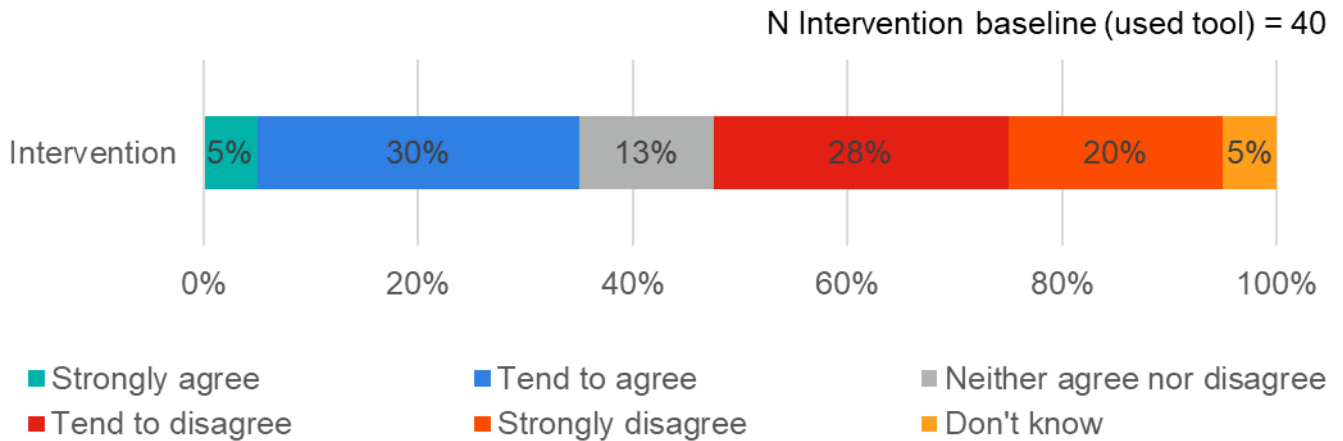
"I've paid extra this winter to avoid the monthly direct debits increasing. For me it's important to be able to budget monthly. It's harder because you have to find the extra money. Personally, I'm managing OK, it's not easy but I'm managing alright."

In one case, the trialist said that the SENS MEETS intervention played a role in how the household managed its bills, while others did not see any influence from being in the trial. The fact that there was low uptake of the product may also indicate a perception amongst those forming the intervention group that the product was not sufficiently useful to them.

At the end of the trial, a third (35%) of intervention group respondents who engaged with the intervention found it easier to control their energy bills (Figure 5.3), while around half (48%) did not agree with this statement.

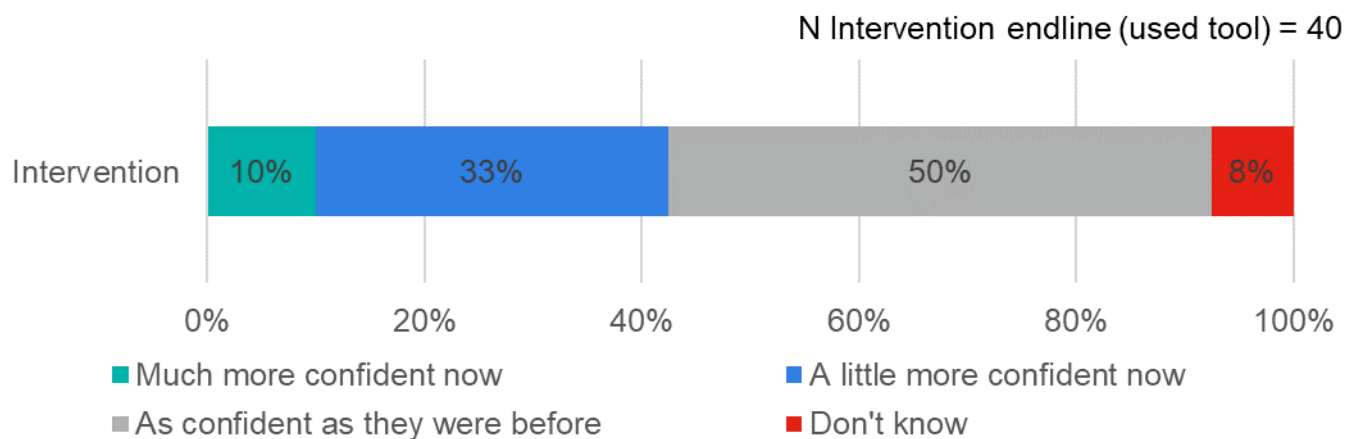
¹³ <https://www.ofgem.gov.uk/publications/price-cap-increase-ps693-april>

Figure 5.3: Agreement with the statement: “I have found it easier to control how much I spend on energy since I started to engage with the product”.



Overall, most intervention respondents (93%) had either an increased or retained confidence in estimating their energy bills (Figure 5.4).

Figure 5.4: Perception of confidence in knowing how much a household spends on energy each month (N = 40).



These survey results corroborated the lack of an observed effect on gas and electricity consumption, as investigated in the primary analysis.

5.3 Reduced unoccupied heating hours

Based on the endline survey results, the SENS MEETS intervention did not contribute to changing trialist energy behaviours at home. When asked whether they heated rooms that were not being used to the same temperature as those that are used at home, 40% of intervention respondents agreed, while 58% disagreed, both at the beginning (N = 92) and at the end (N = 40) of the trial. No change was observed in the control group, where 33% of respondents agreed at both phases of the trial (N = 141), while 60% disagreed at the beginning and 61% disagreed at the end.

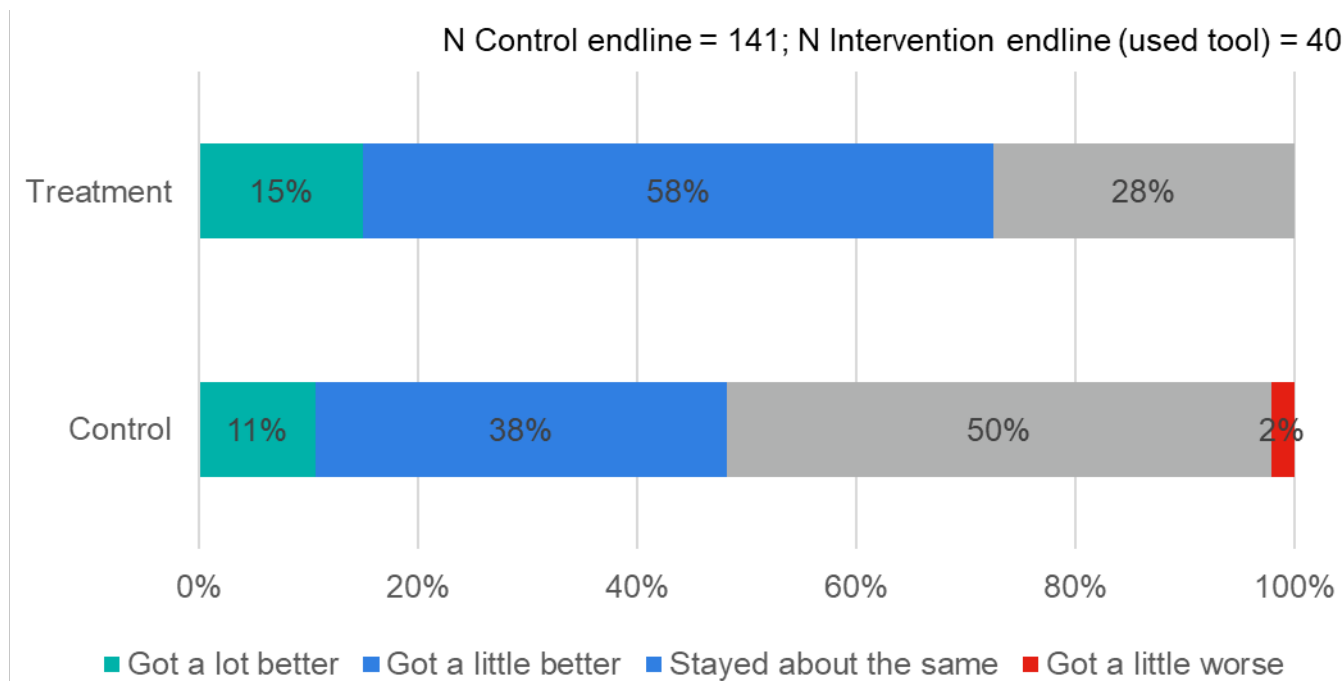
While no changes were observed when comparing used and unused heated rooms, behaviour did change slightly within the intervention group when trialists were asked whether they would leave the heating on when going out for a few hours. Intervention respondents agreed in 36% of cases at the beginning of the trial (N = 92), with the percentage indicatively going down to 28% by the end of the trial (N = 40). This decrease was not observed in the control group, where the percentage of respondents agreeing decreased marginally, from 41% at the beginning to 39% at the end of the trial (N = 141 at both stages). The fact that this change in behaviour did not translate in changes in the trialists' energy consumption might be due to how often they turned the heating off, for how long and external factors (e.g. outdoor temperature).

5.4 Increased understanding of energy use and drivers of energy consumption

Although the SENS MEETS intervention did not show an effect on energy consumption usage, it did appear to moderately improve trialists' knowledge of their energy use at home. When asked whether they knew what uses the most energy at home, intervention respondents agreed in 85% of cases at the end of the trial (N = 40), compared to 78% at the beginning (N = 92), an indicative increase of 7%. The number of those disagreeing indicatively decreased from 17% to 10%. This percentage change is much bigger than what was observed for trialists in the control group, where the proportion agreeing indicatively marginally increased from 77% to 79% (N = 141).

The intervention also seemed to improve the level of understanding of their total energy use at home (Figure 5.5). While it indicatively appeared to get better for 49% of respondents in the control group (N = 141), compared to 45% at the beginning of the trial, the level of understanding in the intervention group indicatively improved for 73% of respondents (N = 40), up from 59% at the beginning of the trial (N = 92). However, of the 29 intervention respondents that said that their understanding had got better, 72% pointed to reasons "mostly or entirely other" than the information received as part of the SENS MEETS trial, while only 28% recognised the intervention as the main reason for improvement.

Figure 5.5: Perception of change in understanding how energy is used within the household (N Control = 141; N Intervention = 40).



This was supported by the responses collected during the interviews at the end of the trial. Some interviewees felt that they had a deeper understanding of patterns in their energy consumption at home, due to the use of the logger, and receipt of their heating reports and coaching messages during the trial.

“Yes, [there is] definitely a feeling of being more energy conscious now because of the heating report and because of the reminders coming through via coaching emails.”

“It’s helped me to appreciate my energy use more than it did before. Maybe not gone far enough to tell me how to improve it but opened my eyes to what is being used and how I am comparing to others in a similar situation.”

“The most useful one was the graph with the temperature variation Monday to Friday and weekend. You know, the minimum, maximum and medium. [...] I think it’s useful to see it and also to see that there is no unusual, bizarre peak anywhere that might be implicating something that was wrong. And also, not too flat suggesting that there is some leakage somewhere.”

However, the improved understanding did not translate into a reduction in energy consumption. Most interviewees found the coaching tips to be too obvious, likely due to the lack of personalisation of tips that was intended to be delivered. They said they were either already aware of the measures they could take to reduce their energy consumption or were relying on smart thermostats to maintain the desired temperature at home. Finally, when asked if they felt more or less confident about changes they could implement at home to save energy, 58% of intervention respondents at the end of the trial (N = 40) felt much more (10%) or a little more confident (48%), while only 40% felt just as confident as they were before. No respondent in the group expressed feeling less confident.

A similar pattern also emerged during the in-depth interviews, where most trialists indicated they were aware of the measures they could take at home to reduce their energy consumption, both for economic and environmental reasons. Most of the respondents had already adopted insulation (e.g. wall, loft) and energy efficiency measures (e.g. new, more efficient boilers) where possible or were looking into further improvements:

“We have increased the energy efficiency with a new boiler and extra insulation in where we can. We are on a programme of changing windows and doors. So things are improving but progress is slow.”

“We are aware of different things that we could do. Planning to do double glazing. We know loft insulation could be better, boiler could be better.”

However, a small proportion of interviewees expressed concern with the cost and payback period associated with some of the technology measures they could implement going forward (e.g. heat pumps, solar panels), suggesting that this may be a factor prohibiting households in making these types of changes:

“There are all sorts of changes we could make to it; we just can’t do it. We could have roof insulation, solar panels, we already have double glazing but could have triple glazing a different sort of heating. We’ve put lightbulbs in, when we renew anything we make sure they are A rated.”

6 Conclusions

This section discusses the results of the SENS MEETS trial evaluation and highlights the implications of its findings, along with considerations about its limitations, lessons learnt and future opportunities.

Ultimately, a robust quantitative assessment of energy savings could not be made, and the evaluation was unable to provide definitive evidence that the SENS MEETS product did or did not impact upon energy consumption savings. The trial had a lower number of trialists than originally planned, and the intervention was not delivered as intended both in terms of the functionality offered to consumers or the duration of the trial.

The challenges, related to COVID-19 and the wider retail market, led to several operational challenges, including; a lower than expected number of customers eligible for recruitment; a slower and reduced recruitment including where customers had not previously provided consent at installation to collect half-hourly smart meter data (necessary to deliver MEETS); a lower than anticipated uptake of components (e.g. several trialists in the intervention group did not order a logger or send back the data collected by the logger); and changes in the coaching component which could no longer be delivered as intended i.e. personalised and of expected duration.

Igloo Energy Supply Limited becoming insolvent during the trial, likely had the strongest impact on the delivery of MEETS. Firstly, in terms of trial recruitment, which prior to this was progressing well. Secondly, given that the personalised coaching component (informed via accessing half-hourly smart meter data) was expected to have had the biggest impact on gas consumption savings. As such, the changes here, from personalised to generic coaching, reduced the expected effect size to be achieved (also meaning that a higher sample size, than originally calculated, would have been required in order to detect any impact).

However, despite these challenges and although no detectable effect of the SENS MEETS intervention was observed during the analysis upon gas consumption, the intervention appeared to have had an effect on trialists' perception of their own energy use at home in terms of increased understanding. Furthermore, based on the qualitative interviews, most trialists were satisfied with the SENS MEETS product and could appreciate the value of this kind of intervention.

Glossary

ANCOVA	Analysis of Covariance
AQ	Annual Quantity (gas)
ATE	Average Treatment Effect
BAU	Business as Usual
BEAMA	British Electrotechnical and Allied Manufacturers' Association
BEIS	Department for Business, Energy and Industrial Strategy
BIT	Behavioural Insights Team
BST	British Summer Time
CA	Contribution Analysis
CAD	Consumer Access Device
CHP	Combined heat and power
CIC	Community Interest Company
CMO	Context-Mechanism-Outcome
CO ₂ e	Carbon dioxide equivalent
COVID-19	Coronavirus Pandemic
CP	Competition Partner
CRL	Commercial Readiness Level
DCC	Data Communications Company
DESNZ	Department for Energy Security and Net Zero (formerly BEIS)
EAC	Estimated Annual (energy) Consumption
ECA	Energy Consumption Analysis
EL	Energy Local
ELC	(SENS) Energy Local Club

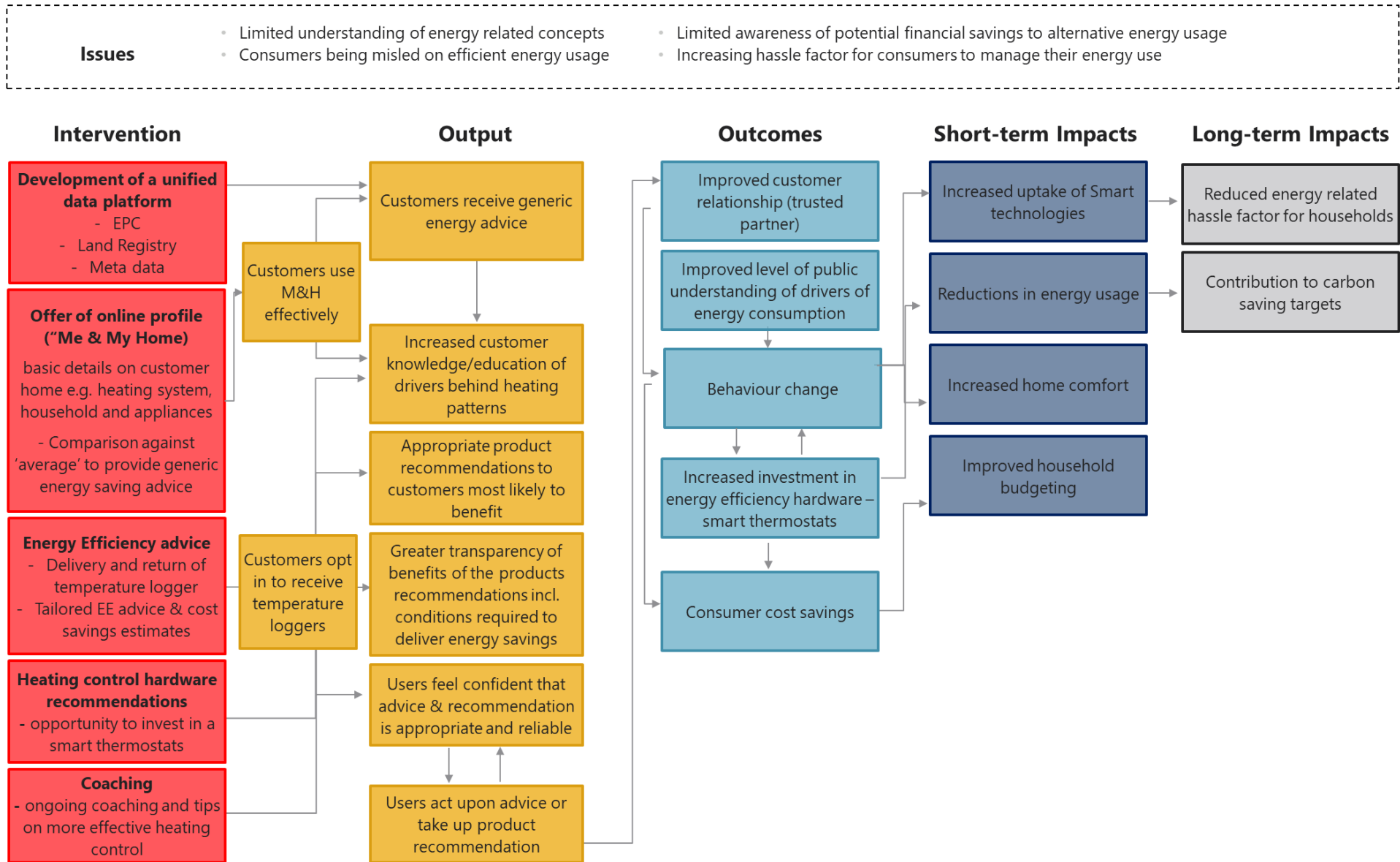
EPC	Energy Performance Certificate
GDPR	General Data Protection Regulation
GEO	Green Energy Options Ltd.
HAN	Home Area Network
HDD	Heating Degree Day
ICE	Igloo Customer Engine
IDEAS	Intelligent Digital Energy Advisory (SENS project)
IHD	In-Home Display
IMD	Index of Multiple Deprivation
ITT	Intention to Treat
KW	Kilowatts
kWh	Kilowatt-hour
M&MH	Me & My Home profile
MDE	Minimum Detectable Effect
MEETS	More Effective and Efficient Thermal comfort with Smart meter data (SENS project)
MI	Monitoring Information
MOP	Meter Operator
MPAN	Meter Point Administration Number
OLS	Ordinary Least Squares
OWL	A brand of electricity monitor used to monitor consumption in Roupell Park
PSM	Propensity Score Matching
RCT	Randomised Controlled Trial
SEC	Smart Energy Code
SECAS	Smart Energy Code Administrator and Secretariat

SENS	Smart Energy Savings Competition
SENS GenGame	SENS Energy Saver app (SENS project)
SEN-ST	Smart Energy-Smart Thermostat (SENS project)
SERL	Smart Energy Research Laboratory, based at University College London
SM	Smart Meter
SMETER	Smart Meter Enabled Thermal Energy Ratings
SMETS	Smart Metering Equipment Technical Specifications
SMETS1	Smart Metering Equipment Technical Specifications - First Generation
SMETS2	Smart Metering Equipment Technical Specifications - Second Generation
SMS	Smart Metering Services
SoLR	Supplier of Last Resort
TDEL	Trial Design and Evaluation Lead
TOT	Treatment on the Treated
TOU	Time of use
TOUT	Time of Use Tariff
TP	Trial Protocol
TRL	Technology Readiness Level
UCL	University College London
WAN	Wide Area Network

Annex A – Theory of Change

This section presents the SENS MEETS Theory of Change, which sets out the issues the intervention is trying to address, the core components of the intervention itself, the outputs it was expected to deliver, the outcomes which the intervention hoped to achieve, and ultimately, the impacts of the intervention.

Figure A.1: SENS MEETS Theory of Change



Annex B – SENS MEETS Trial Sample Journey

This section presents an overview of the trial and shows the number of trialists involved in each step of the intervention delivery and analysis.

Table B.1: SENS MEETS trial sample journey

Milestone / stage / sample		Number / count (households)	Date (where applicable, and including start and end date as needed)
Number of households / customers contacted to participate in trial (total)		6,667	August 2020 - September 2021
Number of households / customers that agreed to participate	Intervention	932	
	Control	944	
Number of households / customers providing consents to be contacted for TDEL research	Intervention	932	
	Control	944	
Number of households / customers providing consents for collection/ provision of energy consumption data via Smart Energy Research Laboratory (SERL)	Intervention	932	
	Control	944	

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Milestone / stage / sample		Number / count (households)	Date (where applicable, and including start and end date as needed)
Number of households onboarded to SERL	Intervention	932	August 2020 - September 2021
	Control	944	
Number of households / trialists receiving component features of packaged intervention	Me and My Home (at least partially completed)	891	August 2020 - September 2021
	Received heat logger	598	November 2020 – December 2021
	Returned heat logger data	313	January 2021 – February 2022
	Received heating report	304	March 2021 – February 2022
	Received coaching messages, i.e. the entire intervention	265	December 2021 – March 2022
Number of withdrawals across Trial period (up to end March 2022)	Change of tenancy	6	August 2020 – March 2022
	Change of supplier	60	

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Milestone / stage / sample	Number / count (households)	Date (where applicable, and including start and end date as needed)	
	Withdrawal of consent	288	
	Other (On Hold)	3	
Final achieved sample (Sample at the end of the trial period, accounting for churn of trialists)	Intervention	742	N/A
	Control	777	N/A
Final achieved sample for quantitative analysis (i.e. less records excluded for e.g. missing or implausible data) – by type. Intention-To-Treat (ITT)	Intervention	701(gas) / 731 (electricity)	N/A
	Control	730 (gas)/ 762 (electricity)	N/A
Final achieved sample for quantitative analysis (i.e. less records excluded for e.g. missing or implausible data) – by type. Treatment-On-the-Treated (TOT)	Intervention	252 (gas)/ 264 (electricity)	N/A
	Control	730 (gas)/ 762 (electricity)	N/A
Number of households excluded and reasons:	Missing/unrealistic energy consumption data	82	N/A

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Milestone / stage / sample		Number / count (households)	Date (where applicable, and including start and end date as needed)
Baseline survey issued / response rate (intervention group)	No. of contacts available to be contacted (i.e. those with valid contact details)	780	December 2020 – December 2021
	No. of completed interviews	352	
	Completion rate	45%	
Baseline survey issued / response rate (control group)	No. of contacts available to be contacted	782	December 2020 – December 2021
	No. of completed interviews	346	
	Completion rate	44%	
Endline survey issued / response rate (intervention group)	No. of contacts available to be contacted	277	March 2022
	No. of completed interviews	117	
	Completion rate	42%	
Endline survey issued / response rate (control group)	No. of contacts available to be contacted	346	March 2022
	No. of completed interviews	141	

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Milestone / stage / sample	Number / count (households)	Date (where applicable, and including start and end date as needed)
	Completion rate	50%
Qualitative interviews completed with intervention group trialists	15	February 2022 – March 2022

Annex C – Technical Appendix

This section presents technical figures and data referred to in the main text.

Statistical methods

Within the primary outcome statistical analysis framework, the average difference in gas consumption was tested for significance using a regression-based approach (ANCOVA), controlling for pre-intervention measure of consumption, and other variables of interest (for example, the IMD Quintile, engagement data) were used, where the binary indicator distinguishing intervention and control group membership included in the model carried the impact effect mean difference. The impact effect coefficient was significance tested at the 95% confidence level to determine if it was less than zero, using a standard t-test.

An ANCOVA was also used to test for any off-setting outcomes in electricity energy consumption. Since this was not the primary outcome of the trial, no minimum detectable effect (MDE) for electricity consumption was estimated.

To calculate the daily gas and electricity consumption for each trialist during the trial, the 48 half-hourly measurements recorded in each day were summed, where available, after removing unrealistic values or records with the wrong timestamp. If not all 48 measurements were available for a day, the daily estimate from the smart meter was used. To estimate the average daily gas and electricity consumption for each trialist, only the data in months that had at least 50% of daily records available were used. The average was then weighed based on the number of days of every month each home was in the trial.

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